WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

A Scranton Gillette Publication

SEPTEMBER 1956

A Filtration Plant of Unusual Design for Lynchburg, Va.
(Pages 383-391)

Direct Utilization of Sewage Plant Effluents
(Pages 417-423)

Legal Aspects of Water Fluoridation
(Pages 399-405)

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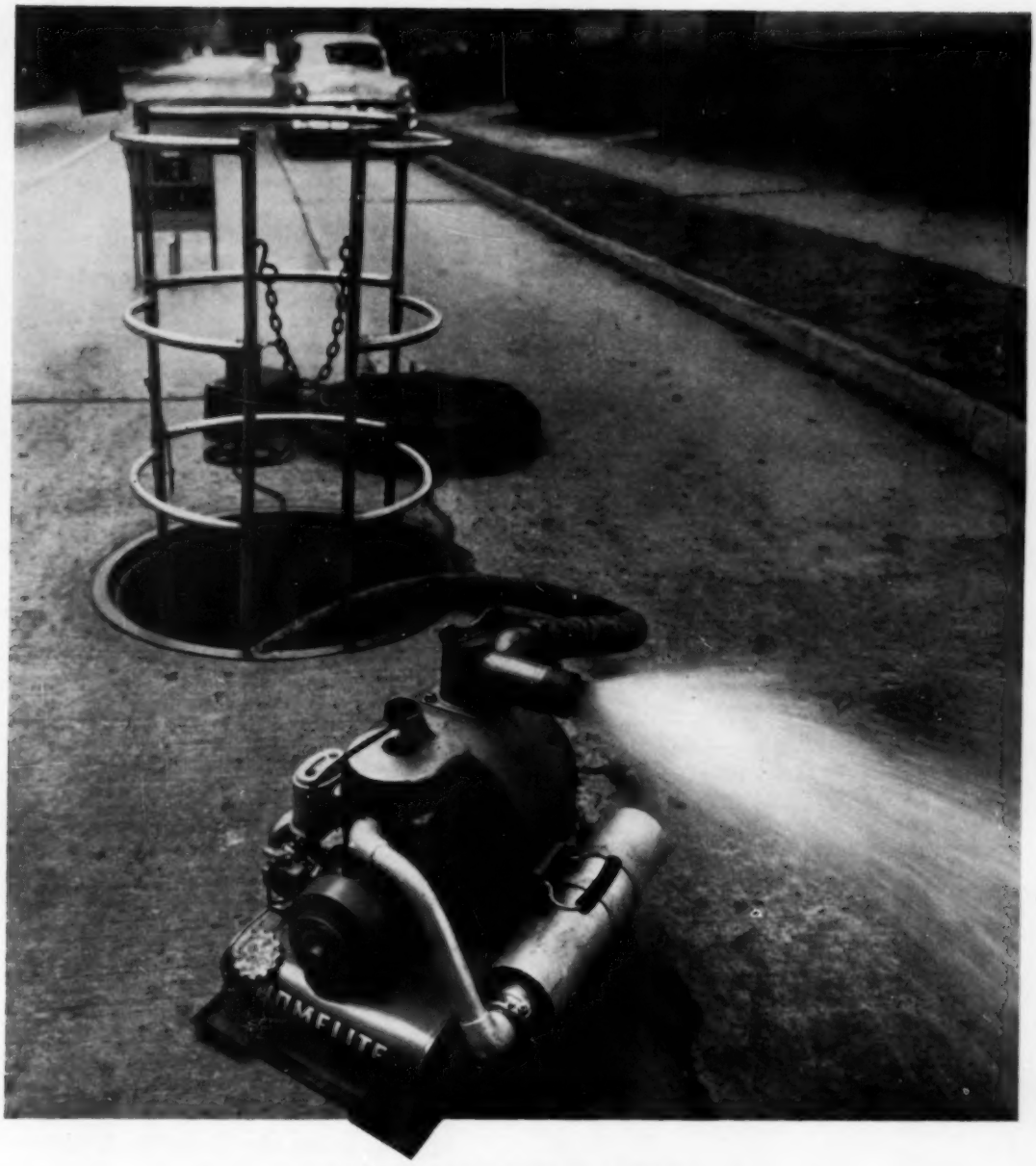

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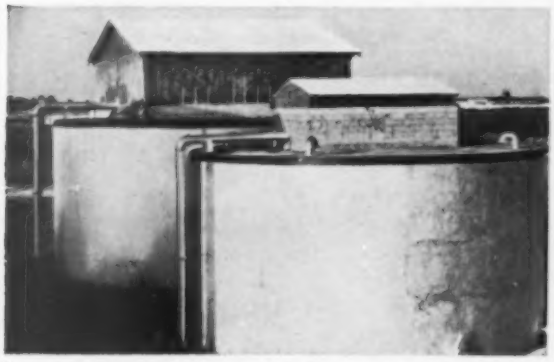
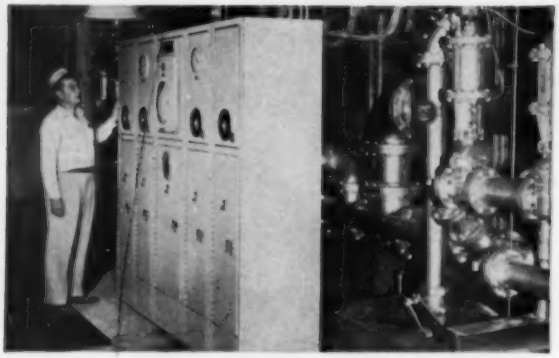
regenerating its softeners with sea water

1. Pumps draw sea water from wells beneath this station. Being inland, these wells deliver a partially filtered sea water. (Regenerating costs are now $25 less per million gallons than when dry salt was used.)



2. To prevent marine growths which would foul equipment, the sea water is aerated and chlorinated.

3. Sea water then passes through Permutit pressure filters (left) and is ready for regenerating the Permutit softeners (right). Sea water pumpage is kept to a minimum because high-capacity Permutit Q, used in the softeners, requires less salt for regeneration.



4. City Engineer George A. Gieseke inspects the Permutit control panel. It backwashes, regenerates and rinses the 4 newest softeners and places them on the line . . . *all without aid from the plant operator!* Two men per shift operate the entire water plant.

5. Hollywood is growing fast. Their first four Permutit softeners went on the line twenty years ago. Now there are 12 . . . and plant space for more. "We're in good shape," says City Engineer Gieseke.

It's easy to see why Consulting Engineers *Reynolds, Smith & Hills* chose Permutit equipment . . . for its long service life and low operating costs. And we'll be glad to help you make sure your water supply is "in good shape" for the future. Write to: Dept. W-9, The Permutit Company, 330 West 42nd Street, New York 36, New York.

WATER CONDITIONING HEADQUARTERS

PERMUTIT

WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

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Philadelphia's Incentive Pay Plan Boosts Meter Shop Output .....*Arnold*
Water Reclamation from Sewage a Reality ..... *Rawn & Bowerman*
The New Filtration Plant of Corpus Christi, Texas ..... *Noyes*
Operation and Maintenance of Water Distribution Systems .....*Miller*
Inspecting and Repairing Steel Water Tanks .....*Jackson*
Ways of Cutting Operating Costs in Water Treatment .....*Hirsch & Lowe*
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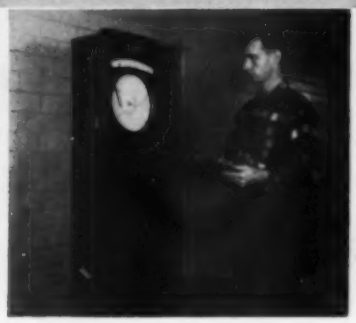
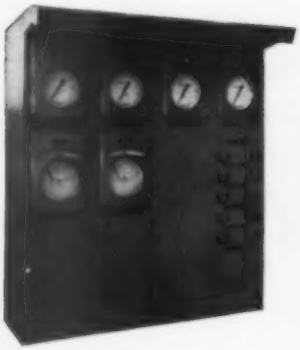
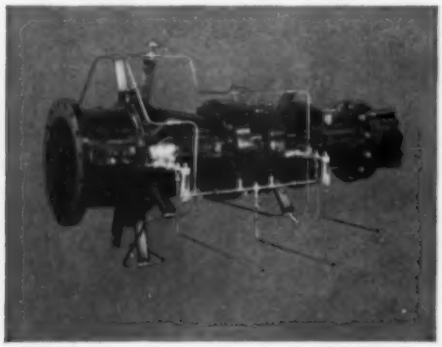


Builders Chronoflo Electric Receiver for remote totalizing, indicating, and recording of raw sewage flow at Mt. Vernon, Ohio, Sewage Plant.

24" Kennison Nozzle, which, with Builders Type M Totalizer-Indicator-Recorder, meters sewage influent at Eslava Creek Sewage Disposal Plant, Mobile, Alabama.



Builders Master Control Panel at New Rochelle, N. Y., Sewage Treatment Plant.



Builders Venturi Tube with hydraulic operated vent cleaners and Flush Check System for trouble-free metering of sewage and sludge flows.

Builders Instrument Panel for Hyperion Sewage Treatment Plant at Los Angeles, Calif. . . . gauges indicate air/sewage ratio, return sludge/sewage ratio, aeration air, raw sewage, and return sludge.

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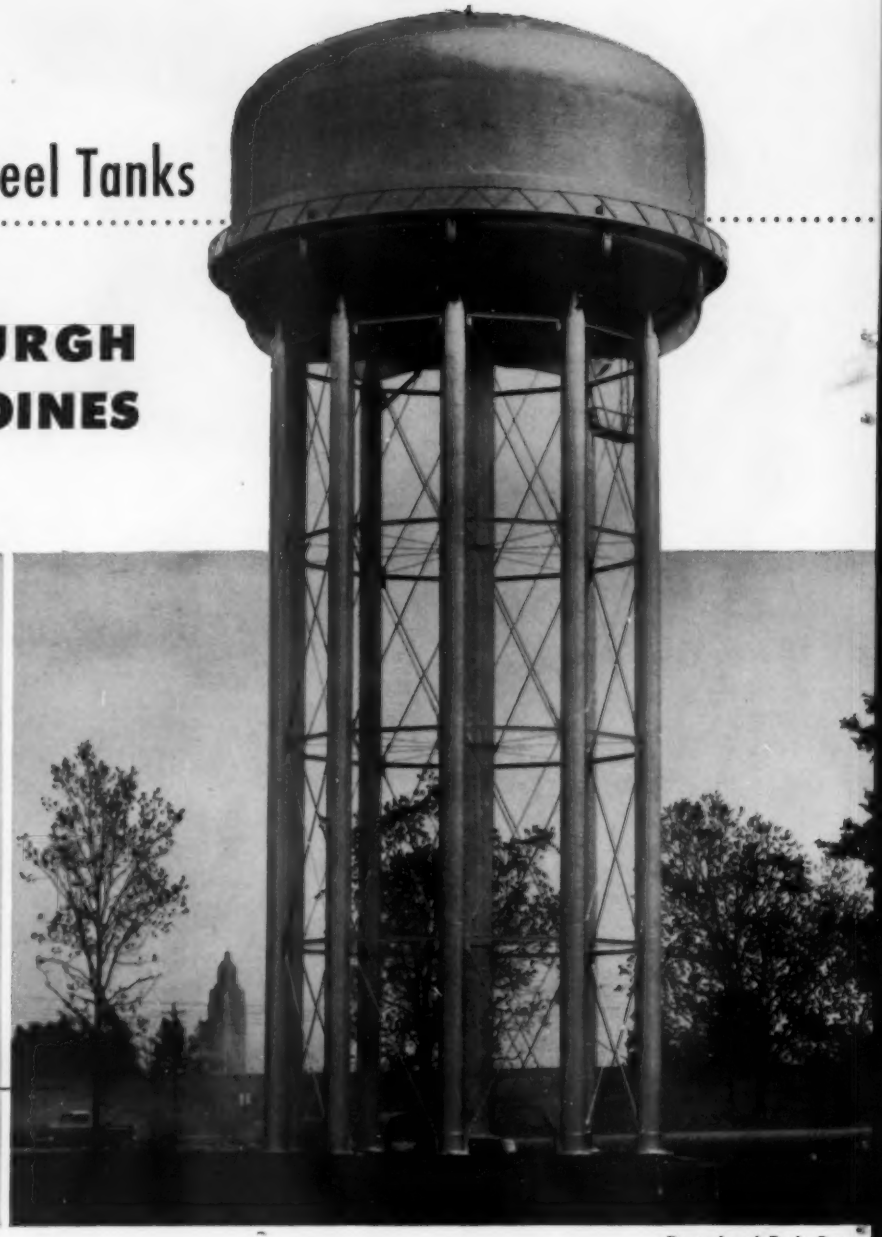

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Symbols of service to the people . . . in the left distance, the tower of Louisiana's beautiful State Capitol at Baton Rouge, and in foreground, the handsome PDM Steel Elevated Tank just completed for the Greater Baton Rouge Port Commission. • Dependable water service at uniform pressures round the clock is assured by the million-gallon capacity of the Radial Cone tank, elevated on a tower 125 ft to bottom. The tank diameter is 71 ft, with 35 ft headrange.
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A Year Of Accomplishment

THE YEAR following the 28th Annual Meeting sees continued progress in our efforts in research, development, and manufacturing at Peapack, and in relatively nationwide application of our Coilfilter for the dewatering of sanitary sludges.

Our Research Laboratory has been in operation for a year, and while nothing monumental has as yet come from the Chemists' labors, we do have a feeling of assurance in keeping an eye on basic research, and this department can be helpful in solving day-by-day practical field problems.

In our manufacturing operation, more tools have been added including a large welding jig for efficient fabrication of the filter drums. Another 8,000 square feet of manufacturing space has been built, and we are able to continue to make an ever increasing number of shipments on time.

In the field, approximately 30 more Coilfilters have gone into successful operation including a number of raw sludge dewatering, and our good reputation continues to grow. Our future looks bright indeed, and we again want to express our appreciation to the Sanitary Field for rewarding our efforts.

Respectfully,
T. R. Komline

KOMLINE-SANDERSON
ENGINEERING CORPORATION
MANUFACTURERS OF THE COILFILTER
PEAPACK, NEW JERSEY

A fast digging rig, the jet trencher is also fast and easy to hook up and detach—only 90 seconds! Makes the ideal working partner to the Oliver OC-3 with loader or back filler attachment.

How the Oliver OC-3 tractor with fast-acting equipment multiplies work power

The OC-3 belies its small size with the big work it can do when equipped with the front end loader. Here it's doing fast cover-up job on sewerage plant project.

—saves cost on big sewer job!

Here, on this big North Carolina sewage plant project, you can see how this versatile Oliver OC-3 uses its rugged, compact design to make the most of digging, dozing and loading equipment.

With the new Oliver Jet Trencher, it's digging 5000 feet of ditch in hard clay...excavating for gasoline storage tanks and septic tanks. Powerful down pressure and smooth, responsive hydraulic control make fast work of these jobs.

Then, with the jet trencher quickly uncoupled and with counterweight added, the OC-3 moves on to speed up other work with its front end loader—fine grade foundation bottoms...back fill ditches...transport pumps, concrete and pipe from one location to another...move heavy equipment.

The OC-3 is a powerful, money-saving worker on any job. See how you can "tailor" the Oliver OC-3 tractor to your exact needs with its eight different attachments. See your Oliver Industrial distributor.

THE OLIVER CORPORATION

400 West Madison Street, Chicago 6, Illinois

OLIVER

a complete line of industrial wheel and crawler tractors and matched allied equipment

Skidding heavy concrete pipe into place is simple with the OC-3. Handy small size and unusual maneuverability plus sure-footed traction get jobs done fast.

Another job the OC-3 handled on this big sewer project. Toting concrete bucket shows bonus capacity of this compact, power-packed crawler.

Let these Westinghouse men help you cut electrical construction costs on water and sewage systems

Co-ordinating the almost endless details of electrical construction for pumping stations, filtration plants, sewage disposal plants and the like is a job for specialists.

Doing it by teamwork can simplify problems, cut costs. It is accomplished by employing specialized know-how on each phase of the specs.

Westinghouse, where ALL types of apparatus for such construction are available in an integrated line, also provides the specialists. Right in your area is a Westinghouse electrical construction engineer who can bring to your problems a team of men tops in their special fields . . . low-voltage distribution, switchgear, motor applications, motor controls, plant or area lighting, ventilation or air conditioning and a host of others.

No job is too small for technical collaboration from your Westinghouse field engineer and his team. No job is too big for them to demonstrate practical savings and technological advantages. Typical applications of Westinghouse apparatus in water and sewage systems are shown below.

Your Westinghouse electrical construction engineer is as close as your telephone. Call him.

Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

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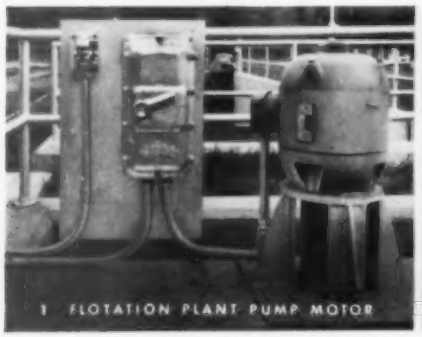
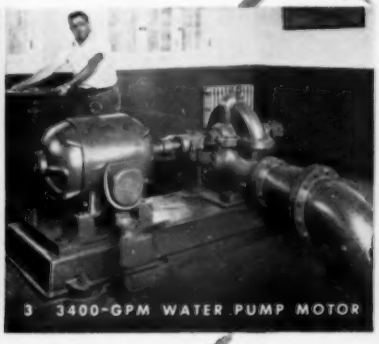


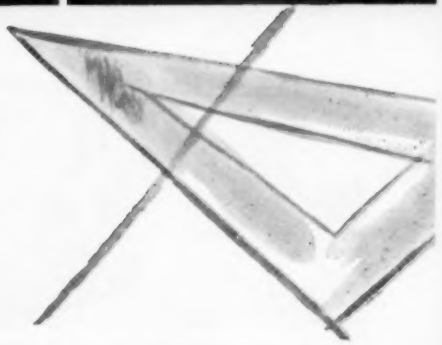
1 FLOTATION PLANT PUMP MOTOR

2 SWITCHGEAR FOR WATER WORKS



3 3400-GPM WATER PUMP MOTOR

1. Vertical-type circulating pump for flotation beds, in Cincinnati, Ohio, driven by 100-hp Westinghouse Life-Line® motor. 2. Block-built from unitized assemblies, this metal-clad high-voltage switchgear vault receives incoming power for the Houston, Texas, Water Works System. 3. Westinghouse 200-hp, 1800-rpm, drip-proof motor driving a 3400-gpm pump at the Gloucester, Mass., pumping station. 4. Simplicity, safety, ease of maintenance are featured in this Westinghouse control center and switchgear distributing power for the San Jacinto, Calif., Water System. 5. 500-hp Westinghouse compressor motor serving a modern power company building. 6. Co-ordinated Westinghouse motor control for the compressor motor shown in illustration 5.



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TUNNELS, BRIDGES, DAMS

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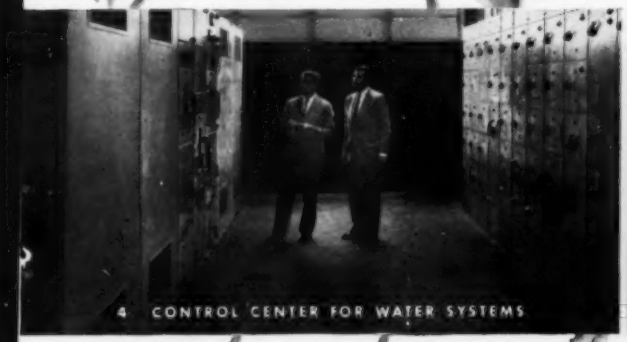
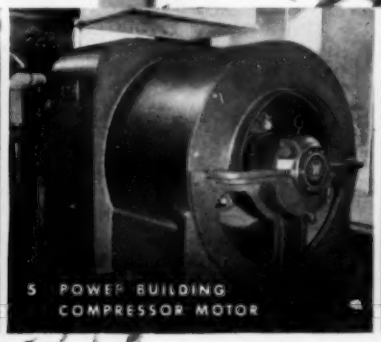
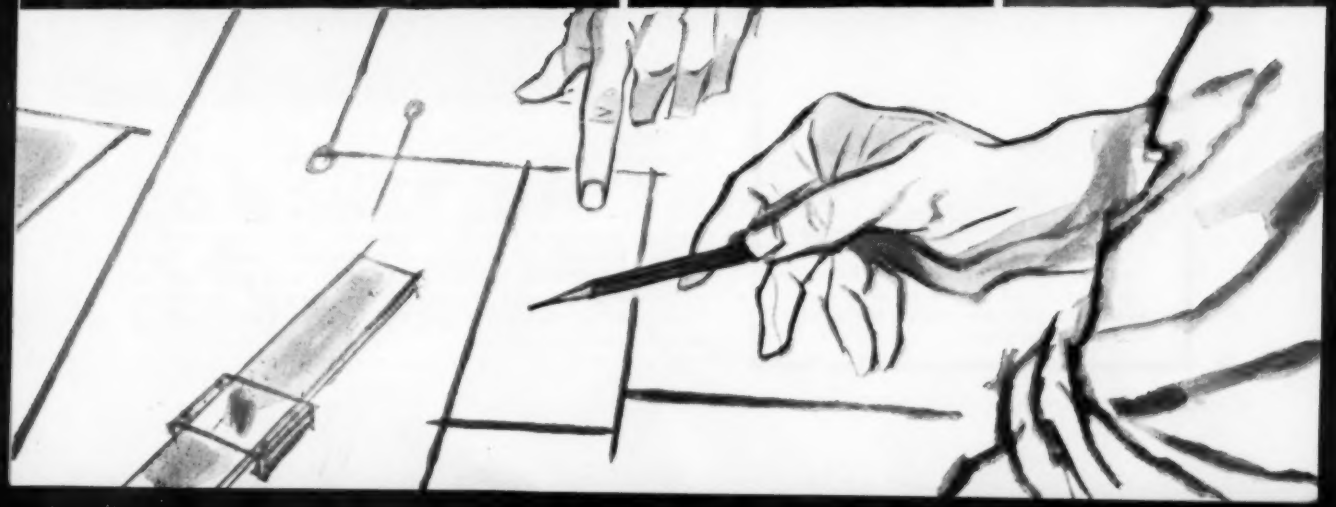


4 CONTROL CENTER FOR WATER SYSTEMS



5 POWER BUILDING COMPRESSOR MOTOR

6 MOTOR CONTROL UNIT



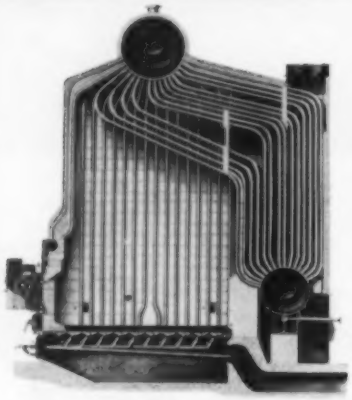
Pittsburgh selects for sewage

Pittsburgh's projected one-hundred-million-dollar sewage treatment system will serve a total of seventy communities having an equivalent population of 1,500,000. More than sixty-three miles of new sewers will be laid to feed raw sewage to the hub of the system – the seventeen-million-dollar treatment plant to be located at Woods Run in the City of Pittsburgh.

Four C-E Raymond Flash Drying and Incineration Units will comprise the sludge disposal system at this plant. Each unit will be capable of handling over 300 tons of concentrated sludge per day.

The Pittsburgh Disposal Plant
J. F. Laboon, *Executive Director and Chief Engineer*
Metcalf and Eddy, *Consulting Engineers*

Incoming sewage will be pumped to the screens and aerated grit chambers and thence flow to the preaeration and settling tanks at far right. The solids will be pumped to the sludge concentration tanks (left foreground) where they will remain for five days. From there the sludge will be pumped to the incinerator building (left background) where it will be dried and burned. The incinerator building will also contain the two C-E boilers.



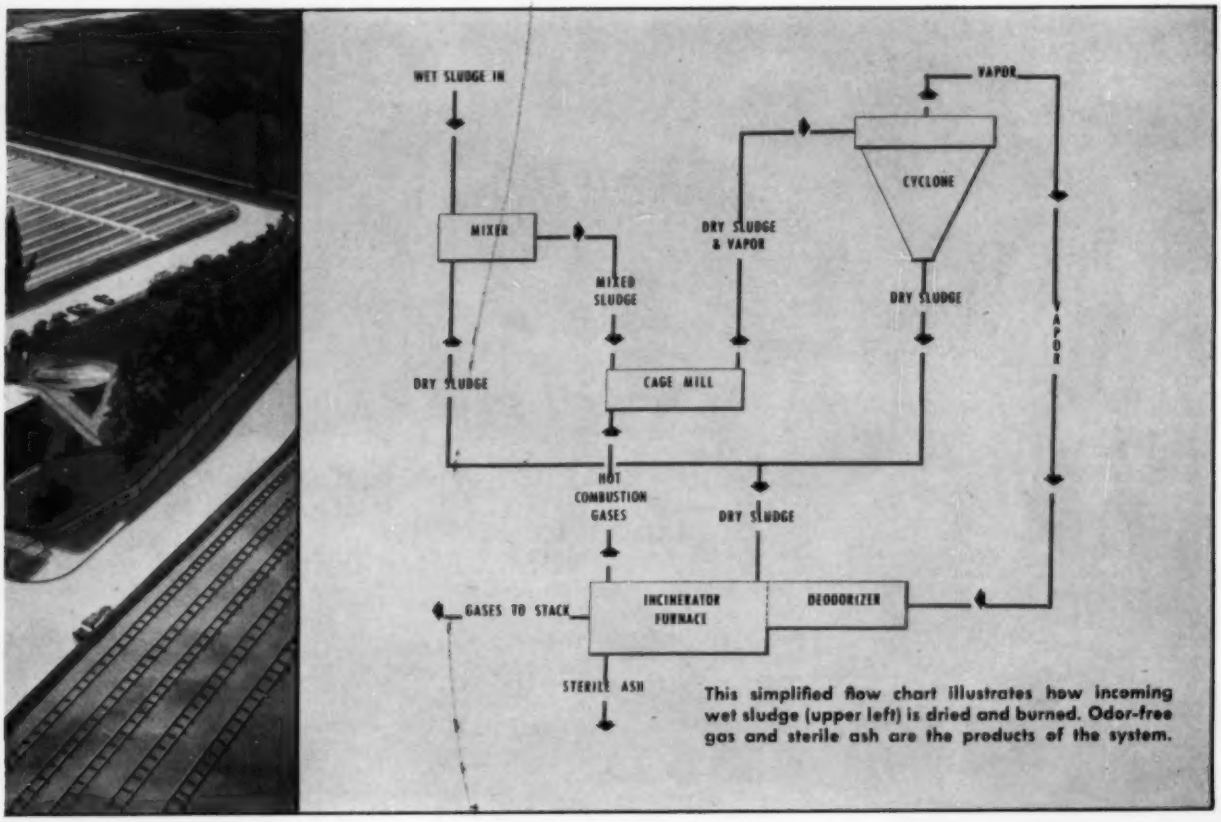
Two C-E spreader stoker-fired boilers, Type VU-10, will provide the steam used to heat sludge in the concentration tanks, and to heat the plant.

C-E Raymond
sludge incineration

The sludge will have a moisture content of 82% and each C-E Flash Drying and Incineration Unit will be capable of burning more than 55 tons of dry solids per day while evaporating more than 250 tons of water. Each C-E Raymond Unit will be equipped with a Deodorizing System which will free the moisture-laden combustion gases of objectionable odors. In addition, each of the four incineration systems will incorporate equipment for the control of fly ash.

Throughout the country, the C-E Raymond Flash Drying and Incineration System is achieving an ever-wider measure of popularity. In fact, *more filter cake is dried and/or burned by the C-E Raymond System than by all other systems combined.*

If you are considering new sewage treatment facilities, investigate *the modern method* of sludge disposal. C-E Raymond specialists will be happy to work with you and with your consultants. No obligation, of course.



This simplified flow chart illustrates how incoming wet sludge (upper left) is dried and burned. Odor-free gas and sterile ash are the products of the system.

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DAILY TIMES

WATER USE UP 75% BY 1975!

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ong public and industrial
and in

Today make sure your community can meet everyone's demands tomorrow

With the water situation already critical in many localities — and competition for water mounting alarmingly among all classes of users — conservation may well be "Operation Survival" for your community. And the first logical step is to set up an accounting of all residential and industrial water use — with Badger Meters.

This precise check sharply reduces water waste, cuts water plant power costs, establishes a fair sharing of water for all, and invariably increases water department revenue... a sound investment in the future.

How critical is the situation? The U. S. Department of Commerce forecasts an increased water demand of 75% by 1975. And the dwindling supply of water could certainly be an acute problem *long before then.*

So make the first strategic move *now.* Let us send you comprehensive literature and, if you wish, set up an appointment with the Badger Meter representative in your area. He will gladly discuss your water problems and furnish complete data on the meters best suited to your community's needs.

Write us today, without obligation.

Water is Vital

Badger Meters have conserved it for 50 years

Badger Water Meters

BADGER METER MFG. CO. • Milwaukee 45, Wisconsin

Giant Wrought Iron intake-discharge lines carry Mississippi River water to the Bayou Lafourche

There are plenty of service life hazards confronting these water lines. From the pumping station at Donaldsonville, La., to the Bayou Lafourche head waters, these lines dip into the ground for long stretches, run under highways and gravelled streets. And all along the way, they transport Mississippi River water.

Small wonder, then, that the engineers of the Department of Public Works, State of Louisiana, took special care in selecting a material that would provide maximum durability.

This thorough investigation of the hazards, plus the desire to eliminate the additional costs of special protective coatings and wrappings, led to the use of wrought iron plate. More than 394 tons of this time-tested material was fabricated into 60-inch and 48-inch lines for intake and discharge line service.

Some of the intake lines were floated to the site of the installation from the shipyard of Avondale Marine Ways, Inc. The discharge lines, welded by Cal-Metal Pipe Corp. of Louisiana, were delivered by truck and pole trailer.

Write for our bulletin, *Wrought Iron for Underground Services.*

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Available in Canada and throughout the world

BYERS *Wrought Iron Tubular and Hot Rolled Products*

ALSO ELECTRIC FURNACE QUALITY STEEL PRODUCTS

a little HTH* goes a long way in sanitizing new water mains

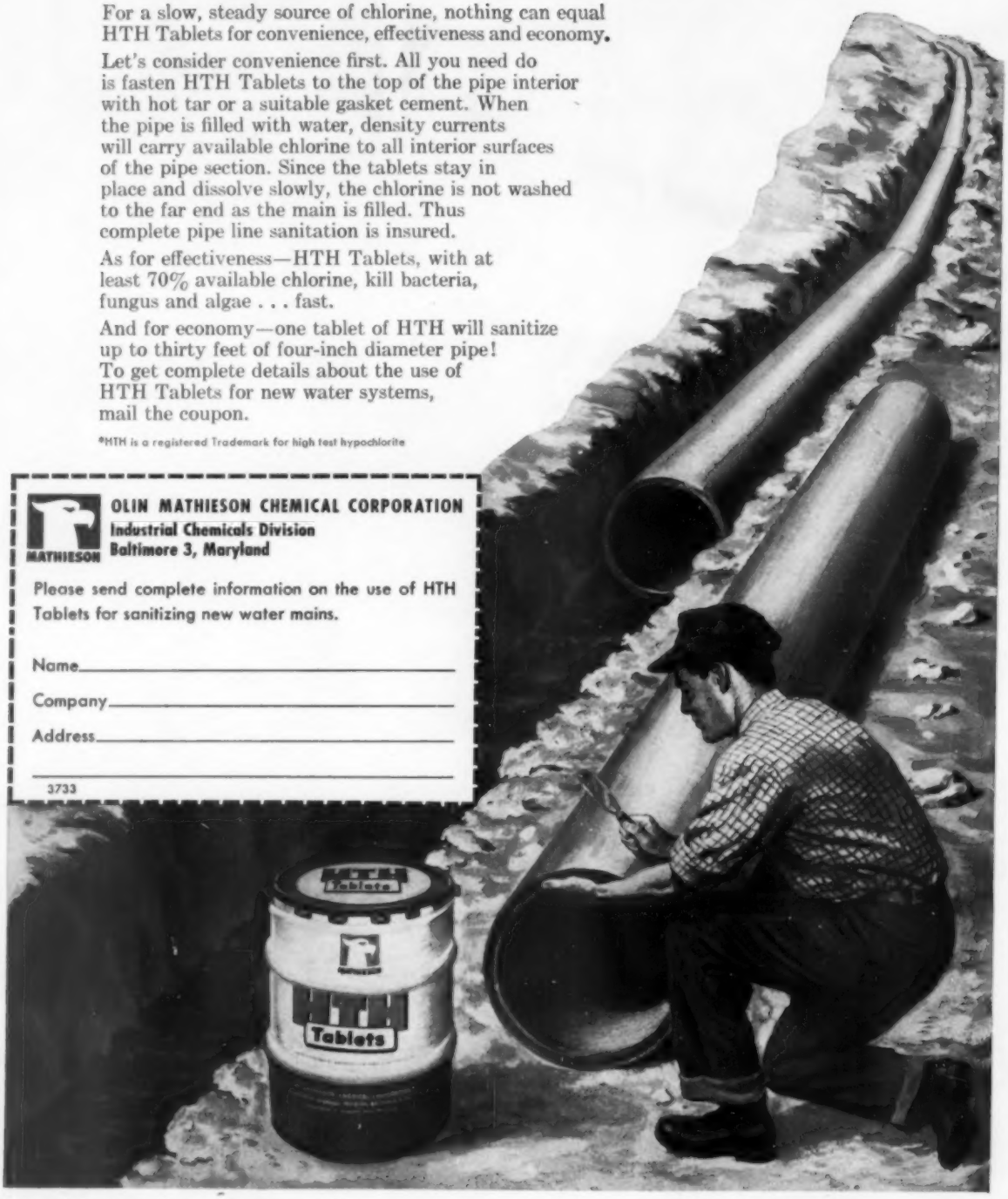
For a slow, steady source of chlorine, nothing can equal HTH Tablets for convenience, effectiveness and economy.

Let's consider convenience first. All you need do is fasten HTH Tablets to the top of the pipe interior with hot tar or a suitable gasket cement. When the pipe is filled with water, density currents will carry available chlorine to all interior surfaces of the pipe section. Since the tablets stay in place and dissolve slowly, the chlorine is not washed to the far end as the main is filled. Thus complete pipe line sanitation is insured.

As for effectiveness—HTH Tablets, with at least 70% available chlorine, kill bacteria, fungus and algae . . . fast.

And for economy—one tablet of HTH will sanitize up to thirty feet of four-inch diameter pipe! To get complete details about the use of HTH Tablets for new water systems, mail the coupon.

*HTH is a registered Trademark for high test hypochlorite



MATHIESON

OLIN MATHIESON CHEMICAL CORPORATION
Industrial Chemicals Division
Baltimore 3, Maryland

Please send complete information on the use of HTH Tablets for sanitizing new water mains.

Name_____

Company_____

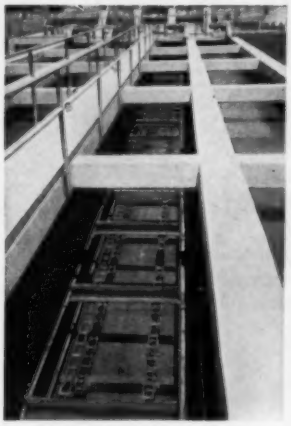
Address_____

_____

3733

See LINK-BELT at the F. S. and I. W. Association's Meeting, Los Angeles, Oct. 8-11

PRE-AERATION increases efficiency of 20 tanks equipped with sludge collectors. Air floats grease, flocculates solids and adds dissolved oxygen to the effluent.



FOUR LINK-BELT grit collectors slow sewage velocity to 1.25 fps . . . and remove grit from lighter solids that remain in suspension.

SLUDGE CAKE is conveyed from vacuum filters by Link-Belt belt conveyors. It is used as "Soil Conditioner" by the City Park, nurseries and home gardeners.

How Sacramento effectively controls ODOR - - POLLUTION - - DISPOSAL

LINK-BELT pre-aeration and sludge removal equipment satisfies rigid water purity standards

SINCE 1949, Sacramento's population and industry have increased 50%. To stop odors and water pollution in the Sacramento River, the city recently installed a new sewage treatment plant equipped with Link-Belt grit collecting and washing equipment, sludge collectors and skimming equipment, and belt conveyors for handling the dewatered sludge. The equipment was included in specifications drawn up by the engineering office of Clyde C. Kennedy, Consulting Engineers.

Link-Belt's complete line of equipment and broad engineering experience provide low-cost, efficient water, sewage and waste treatment for municipalities and industries throughout the country. A call to your nearest Link-Belt office will put you in touch with our sanitary engineers who will work with your consultants and chemists.

14,236

LINK-BELT

SANITARY ENGINEERING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

THE NATION'S No. 1 SOURCE

for dependable pipe line equipment

Like hundreds of Pollard customers, you'll find it mighty pleasant and convenient to order pipe line equipment from Pollard.

Here, under one roof and listed in one comprehensive catalog, are all the time and money saving products you need on the job. Each is guaranteed for dependability, economy. Each is backed by Pollard service.

JOINT RUNNERS

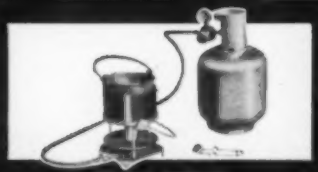
DIAPHRAGM PUMPS

MANHOLE CUSHION

MAKE POLLARD YOUR SOURCE FOR PIPE LINE EQUIPMENT. ORDER FROM POLLARD CATALOG 26.

PIPE CUTTERS

M-SCOPE PIPE FINDER



MELTING FURNACE

CALKING TOOLS

PIPE LINE EQUIPMENT

JOSEPH G. POLLARD CO., INC.

PIPE LINE EQUIPMENT

PIPE LINE EQUIPMENT

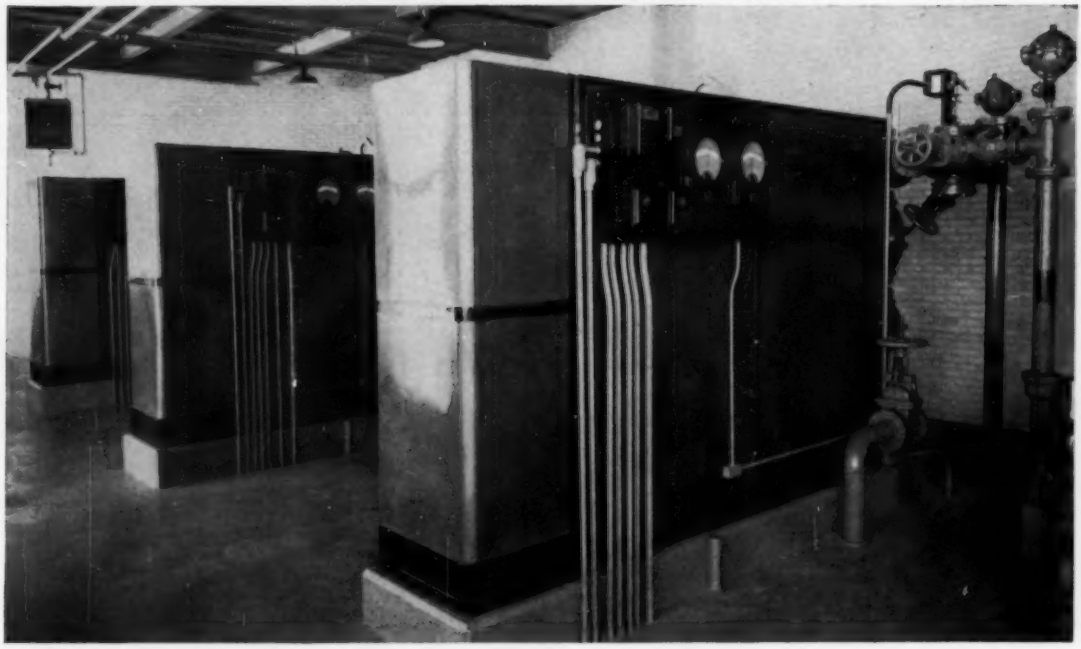
Place your next order with POLLARD

If it's from POLLARD . . . it's the Best in Pipe Line Equipment

NEW HYDE PARK • NEW YORK

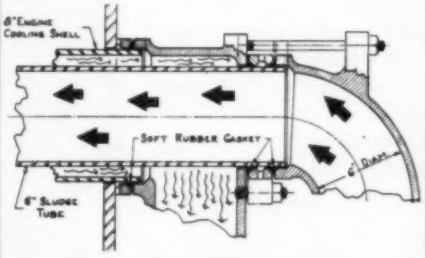
Branch Offices: 1064 Peoples Gas Building, Chicago, Illinois
333 Candler Building, Atlanta, Georgia

Three P.F.T. Heater and Heat Exchanger units serve modern plant at York, Pa.



At York, Pennsylvania . . .

3 P.F.T. Digester Heat Exchangers installed for most efficient operation



POSITIVE SAFETY FROM CONTAMINATION

In these P.F.T. Exchangers, 6" interior tubes carry sludge, while 8" outer tubes carry heating water in the opposite direction (counterflow). Exclusive P.F.T. multiple-gasket joint design makes any leakage of sludge quickly detectable on the *outside* of the unit. This positively prevents contamination of water circulating in the 8" tubes, and safeguards the cooling system against costly clogging.

P.F.T. is the only manufacturer of both *shell and tube* type and *concentric tube* heat exchangers for sewage treatment. York thus could be sure of getting the best suited equipment for their sludge heating operation.

After careful analysis, three *P.F.T. #605 Heat Exchangers* of the concentric tube type were specified. Rated output is 1,000,000 B.t.u. per hour each. All parts are readily accessible. Return bends are easily removed for inspection and cleaning of both sludge and water tubes.

Digesters are economically heated by transferring waste heat from two 150 hp. gas engines to sludge recirculating through the #605 exchangers. *P.F.T. Gas Safety Equipment* protects the digesters and sludge gas system from flash-backs at the engines and boilers.

Design of plant by / *Albright and Friel, Incorporated Consulting Engineers Philadelphia, Pa.*

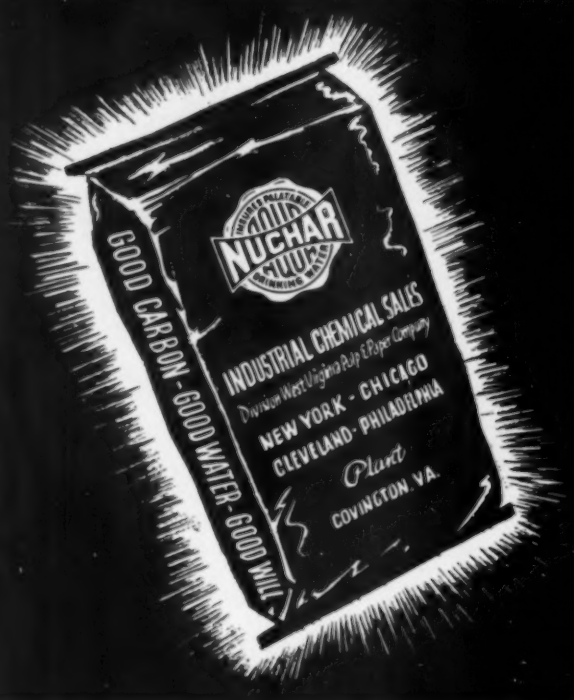
P.F.T.

waste treatment equipment exclusively since 1893

PACIFIC FLUSH TANK CO.

4241 Ravenswood Avenue
Chicago 13, Illinois

Palatability Should Not Be Seasonal



Concentrations of algae, and trade wastes in raw water supplies will vary considerably depending upon weather conditions and stream flow. Therefore, water-plant operators must keep on their toes, making frequent Threshold Odor Tests to check the required dosages of AQUA NUCHAR activated carbon necessary to reduce odor concentrations to provide a palatable water. From the standpoint of economy, these tests are a must, for they indicate when more AQUA NUCHAR is needed, or when the dosage can be cut back.

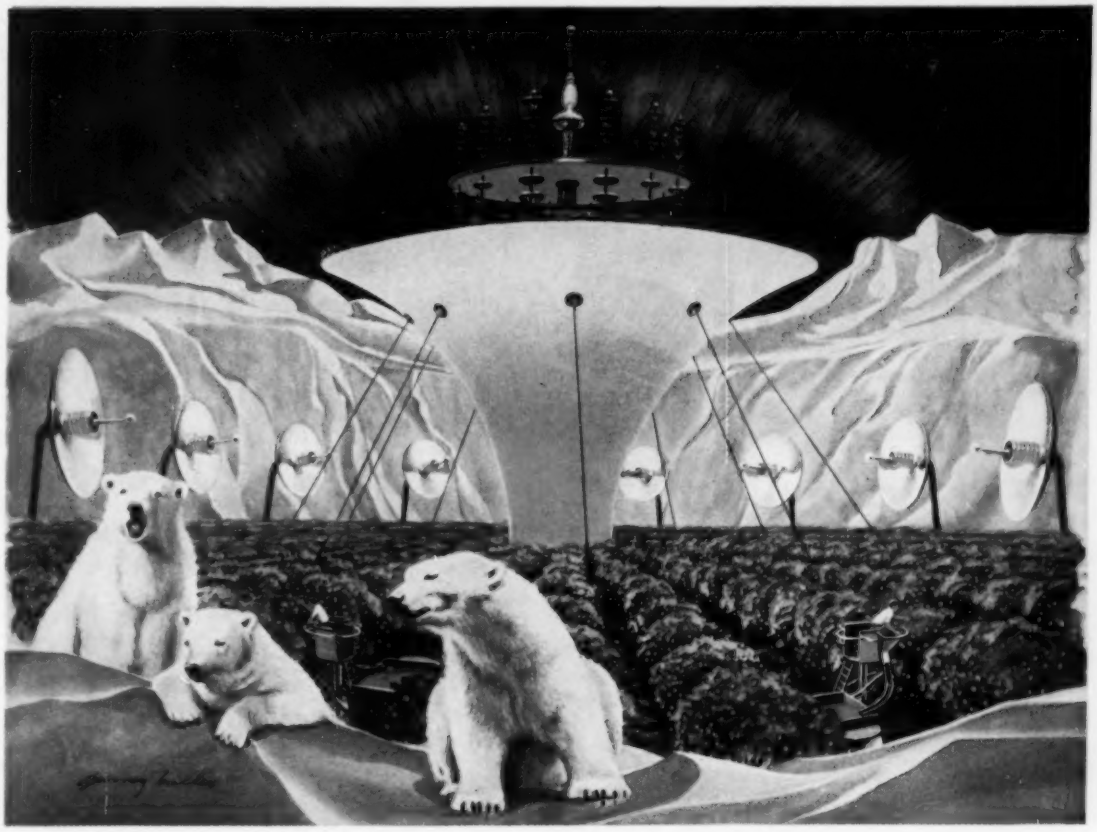
Our Research staff will gladly, without obligation, give your plant a complete odor survey and recommend how and where AQUA NUCHAR can best be used to produce palatable water.

GOOD CARBON · GOOD WATER · GOOD WILL

New York Central Building
230 Park Ave., New York 17, N. Y.
Phila. Nat'l Bank Bldg.
Broad & Chestnut Sts., Phila. 7, Pa.

industrial CHEMICAL SALES
division west virginia pulp and paper company

Pure Oil Building
35 E. Wacker Drive, Chicago 1, Ill.
2775 S. Moreland Boulevard
Cleveland 20, Ohio



Huge solar engines imprisoning the heat of the sun may create islands of fertility in icy wastelands, thus vastly increasing the productive food areas of the earth.

100 years from now...

WE MAY GROW ORANGES AT THE POLES!

What will the world be like generations from now? Wonderful new products and methods will make living easier, pleasanter, safer. But in this marvelous new era, one old friend will still serve efficiently. Water and gas will be carried by rugged cast iron pipe laid today. For more than seventy American water and gas utilities, cast iron mains over a century old are still serving dependably. And modern cast iron pipe ...centrifugally cast and quality controlled...is far tougher and more durable.

U.S. Pipe is proud to be one of the leaders in a forward-looking industry whose service to the world is measured in centuries.

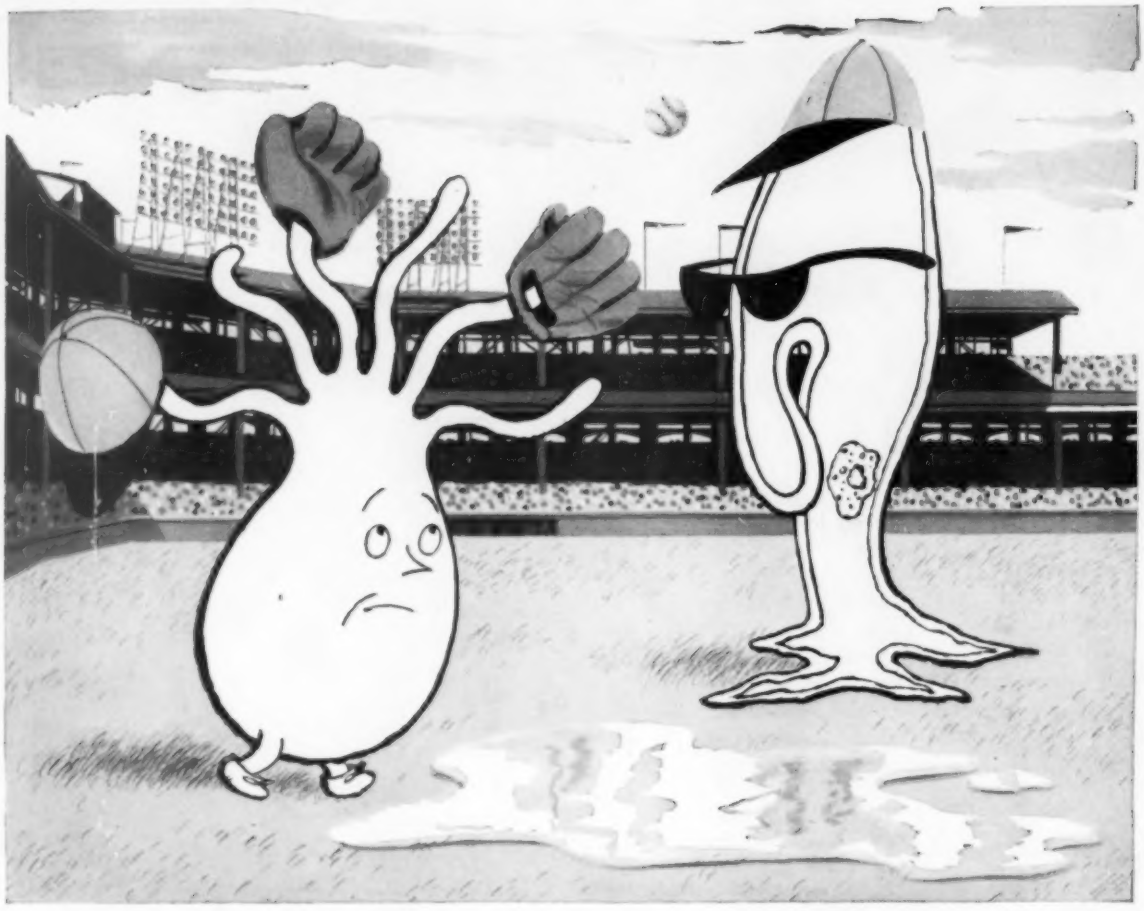
U.S. cast iron PIPE

FOR WATER, GAS, SEWERAGE AND INDUSTRIAL SERVICE

CAST IRON

U. S. PIPE AND FOUNDRY COMPANY, General Office: Birmingham 2, Alabama

A WHOLLY INTEGRATED PRODUCER FROM MINES AND BLAST FURNACES TO FINISHED PIPE.



"Let it go, Algie, the water might be treated with PITTCHLOR®!"

That's right, Algie. One step in water treated with Pittchlor and you're out of the game for good. Pittchlor is sure and instant death to chlorine-susceptible bacteria and algae.

A stable, high-test calcium hypochlorite containing a minimum of 70% available chlorine, Pittchlor works fast and effectively in chlorinating water supplies, treating sewage or wherever the germicidal and deodorizing action of chlorine is needed.

Pittchlor is dry, white and free-flowing. Its granular form permits ease of application either manually or by mechanical feeders. Write for free folder.

For water purification, sewage treatment, and swimming pool sanitation

Stocked by leading jobbers in 5 lb. resealable cans (9 per case), 3¾ lb. cans (12 per case) and 100 lb. and 130 lb. drums.

COLUMBIA-SOUTHERN CHEMICAL CORPORATION
SUBSIDIARY OF PITTSBURGH PLATE GLASS COMPANY
ONE GATEWAY CENTER · PITTSBURGH 22 · PENNSYLVANIA

DISTRICT OFFICES: Cincinnati • Charlotte • Chicago • Cleveland • Boston New York • St. Louis • Minneapolis New Orleans • Philadelphia • Houston Pittsburgh • Dallas • San Francisco

IN CANADA: Standard Chemical Limited and its Commercial Chemicals Division

Tough Problem Solved

F&P Engineering solves Meyersville's problem: Higher fire insurance rates or safe water.

If all the property owners in Meyersville, Maryland were to avoid an increase in fire insurance rates, the main water pressure, during fire emergency, had to be maintained above the allowable minimum.

All other automatic proportioning Chlorinator systems recommended to Meyersville required permanent head losses far in excess of the allowable minimum or were prohibitively expensive.

All, that is, except the F&P Chlorinator. F&P, applying its wide instrumentation and systems engineering experience, utilized standard components to solve Meyersville's problem.

Since its installation the F&P unit has given accurate, maintenance-free, money-saving service.

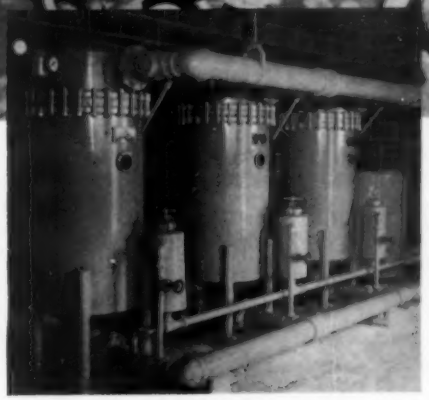
If you have *any kind* of chlorination problem, why don't you call Fischer & Porter now? Write or call today—without obligation—for complete information and engineering data.

FP FISCHER & PORTER

196 FISCHER ROAD, HATBORO, PA.

IN CANADA:
FISCHER & PORTER (CANADA) LTD.
TORONTO 15, ONTARIO

LA1113



Diatomite filters with ALOXITE® tubes give low-cost, dependable swimming pool filtration

Built by Proportioneers, Inc., Division of B.I.F. Industries, Inc., the diatomite filters shown at right effectively filter swimming pool water season after season . . . without excessive maintenance.

Contributing to their successful, economical operation are the Aloxite® aluminum oxide porous tubes or septa that support the diatomite. These have many inherent advantages. For example, pore area is a high percentage of their total area. Pre-coat builds up uniformly. Backwash is uniform and effective. The Aloxite® septa are fine enough to give partially effective filtration without the diatomite in periods of emergency. And they resist acids — which permits cleaning of units clogged by iron and other materials.

This informative 56 page booklet covers porous media for all fields of filtration and diffusion. Write us for your free copy today.

CARBORUNDUM
Registered Trade Mark

Dept. X96 Refractories Division
Perth Amboy, New Jersey

BIG CITY • BIG DEMAND

BIG RIVER Solution: Big Pumps

Capacity 50,000,000 gallons a day

Installed for ST. LOUIS COUNTY WATER COMPANY, NORTH END PLANT, ST. LOUIS, MISSOURI

Intake Pumps: 4 - 150 hp Peerless 36" single-stage vertical turbine pumps.

Booster Pumps: 8 - 500 hp Peerless 22" single-stage horizontal double-suction pumps.

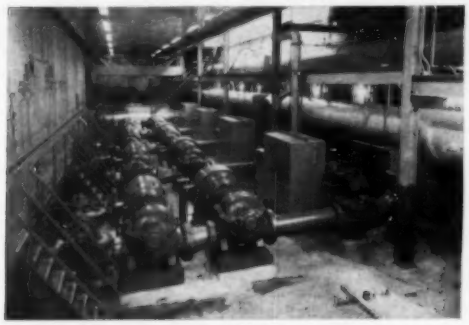
Here's another installation that convincingly demonstrates Peerless' ability to do the complete pumping job efficiently:

vertical pumps for **water supply**
horizontal pumps for **water pressure**

Either way you look at a pumping job—towards horizontals or towards verticals—follow the lead of consulting and water works engineers everywhere. Select Peerless horizontal and vertical pumps from one of the most complete lines of high quality, water handling pumps offered by any manufacturer.

Remember: Peerless builds dependable pumps for *all* water handling services—supplying, circulating, dewatering, drainage and flood control protection—and for all applications—municipal, industrial, commercial and domestic.

BIG VERTICALS—The middle 2 of these 36" single-stage Peerless vertical intake pumps are driven by 150 hp induction motors. The other 2 pumps (same specifications) are driven by wound rotor motors.



BIG HORIZONTALS—These 8 Peerless horizontal single-stage, double-suction pumps are driven by 500 hp motors. Mounted in series, these 22", high service pumps maintain pressure at required standard.

PEERLESS PUMPS

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
301 West Avenue 26, Los Angeles 31, Calif.

fmc

Factories: Los Angeles 31, California and Indianapolis 8, Indiana
Offices: New York; Atlanta; Chicago; St. Louis; Phoenix; San Francisco; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque.
Distributors in Principal Cities. Consult your Telephone Directory.

PLEASE SEND PUMP BULLETINS DESCRIBING

☐ Peerless Horizontal Pumps (Bulletin B-1300) ☐ Peerless Vertical Pumps (Bulletin B-505)

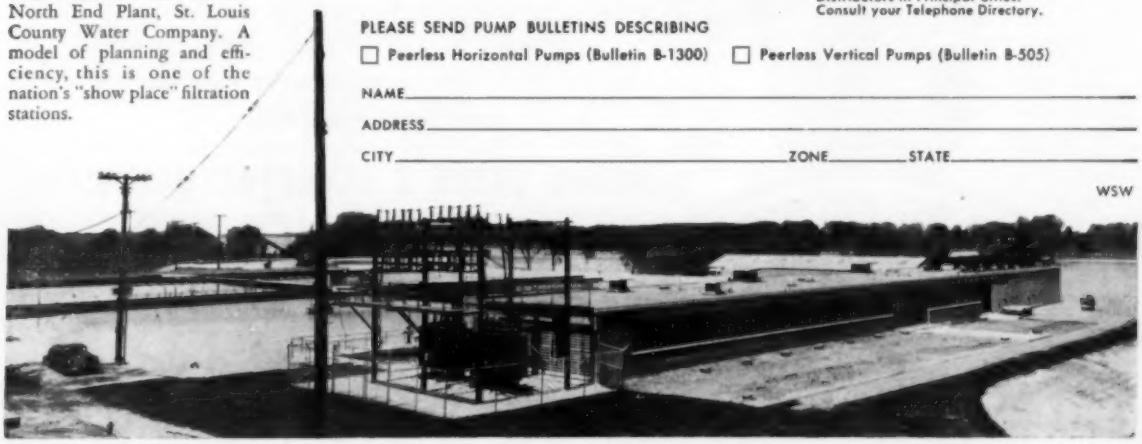
NAME_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

WSW

BIG PLANT—View of the North End Plant, St. Louis County Water Company. A model of planning and efficiency, this is one of the nation's "show place" filtration stations.



How this hydrant

PAYS A BONUS!

It's unique... it's the B-50-B

EVERY new installation of Darling B-50-B A.W.W.A. Hydrants . . . proves the advantages this new hydrant offers you.

Darling's ball bearing design cuts required operating torque more than 50%—an important factor in *any* system. Action is easy, smooth and sure!

Darling "O" ring seals provide a *dry-top, packless* hydrant, minimizing service and maintenance needs and eliminating the hazard of water reaching the operating threads.

This operating surety and low-cost performance of Darling B-50-B hydrants are bonus values that just can't be matched. You can get the B-50-B design in a wide range of Darling hydrant types to meet your particular installation requirements.

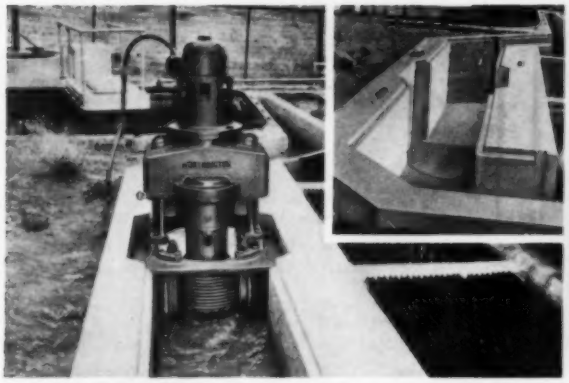
Send for Bulletin 5403

DARLING VALVE & MANUFACTURING CO.

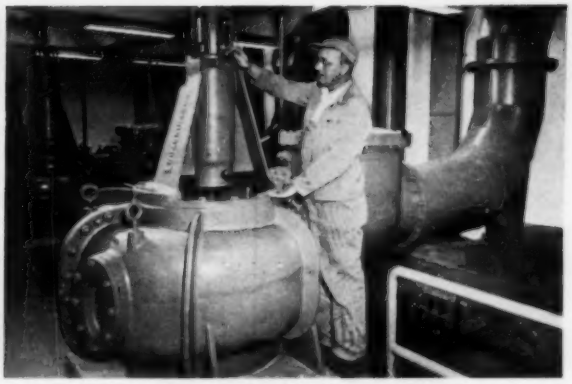
Williamsport 11, Pa.

Manufactured in Canada by
The Canada Valve & Hydrant Co., Ltd., Brantford 7, Ontario.

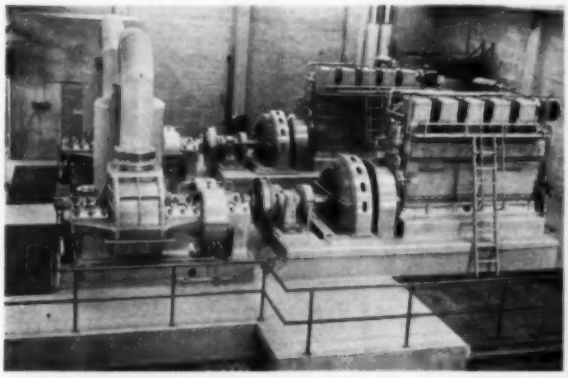
TRADE ® DARLING MARK



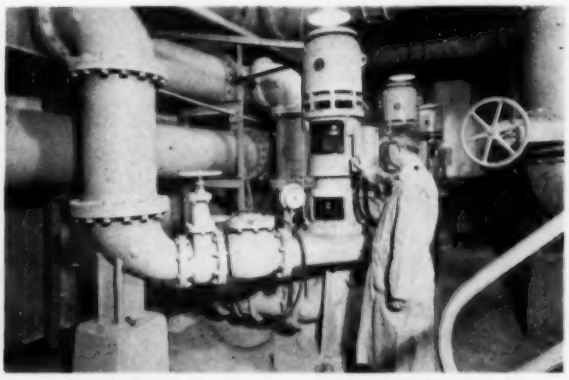
COMMINUTORS. Since raw sewage flows straight through in the Worthington design, the comminutor can be installed in a simple rectangular channel (inset) without expensive masonry work. This one is located at Klamath Falls, Ore.



MIXFLO PUMPS. Available in sizes from 2 MGD to over 300 MGD, Mixflo pumps have non-clogging sewage-type impellers for passing large solids. This one handles raw sewage in the new Salem, Ore., Treatment Plant.



DUAL-FUEL ENGINES. Operating on oil or gas or any combination of both, these Worthington dual-fuel engines drive blowers for the Little Ferry, N. J., Treatment Plant of Bergen County Sewer Authority.



FREFLO PUMPS Available in sizes from 100 GPM to 5 MGD, these Worthington Freflo pumps in the Bethlehem, Pa., Sewage Disposal Plant offer maximum freedom from clogging.

How to get more for your equipment dollar

Check these extra services offered by WORTHINGTON— world's leading builder of sewage treatment equipment

Be sure you take advantage of the extra services offered to municipalities considering sewage treatment plants. Regardless of the size of the installation you plan, whether large or small, here's how Worthington can help you.

Trained specialists will sit down with you and study the situation in the planning stage. They will help you recommend, step-by-step, the best and most up-to-date equipment to do your specific job in the most economic way.

An unbiased recommendation. Because Worthington makes a complete line of engines, compressors, comminutors, pumps, and auxiliary equipment, you get an equipment recommendation based on a broad look at *all* available ways of doing the job.

Unit responsibility. You do business with one company—eliminating delays and inconvenience that can occur when you are forced to co-ordinate the efforts of several suppliers.

Some of the sewage treatment plant equipment built by Worthington include: pumps; gas, dual-fuel, and diesel engines; vacuum pumps; air and gas compressors, and comminutors.

For more information about any of these products, call your nearest Worthington District Office, or write to Section W65, Worthington Corporation, Harrison, N. J. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont. W.6.5.

WORTHINGTON

ALL MAJOR PUBLIC WORKS EQUIPMENT UNDER ONE RESPONSIBILITY

Reduce Pumping and Treatment Plant Costs

Prevent Infiltration with AMVIT* JOINTED CLAY PIPE

Field tests on completed AMVIT installations prove that ground water infiltration can be controlled and prevented.

Engineers can thus reduce infiltration specifications far below accepted standards, use smaller diameter pipe and lower pumping and treatment plant costs.

True Mechanical Joint

The Amvit Joint is a true mechanical joint based on the ball and socket principle. When the pipe is "pushed together", and that's all it takes to make a water-tight joint, the bell and spigot rings are in constant compression. The line is then ready for testing and backfilling.

Available in 4" through 24"

Amvit Jointed Clay pipe, in sizes 4" through 24", together with all fittings is available for immediate delivery in the Northeast and Central States.

For more information, write or call American Vitrified Products Co., National City Bank Bldg., Cleveland, Ohio, or our office nearest you.

The Amvit Joint is made of a plastic material with rubber-like characteristics. Like the pipe, the joint will withstand the most severe underground conditions. Amvit Joint is also furnished on all standard fittings.

*T. M. Registered. Patents Pending

SINCE 1900

AMERICAN

American Vitrified Products Company

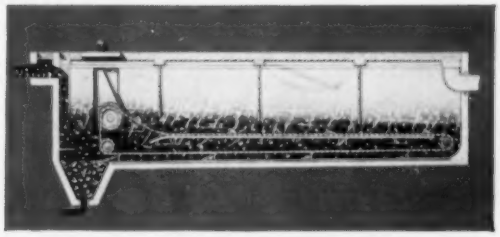
CLEVELAND, OHIO

MANUFACTURERS of: Clay pipe, flue liners, clay liner plates and concrete pipe.

Plants Across the Nation... Brazil, Indiana • Chicago, Illinois • Cleveland, Ohio • Crawfordsville, Indiana • Detroit, Michigan • East Liverpool, Ohio Fenton, Michigan • Grand Ledge, Michigan • Lisbon, Ohio • Los Angeles, California • Milwaukee, Wisconsin • South Bend, Indiana • Uhrichsville, Ohio

THE REX VERTI-FLO

works like magic in cutting high settling costs



The amazing ability of Rex Verti-Flo Clarifiers to reduce costs...assure clearer effluent...increase over-all plant efficiency... is almost magical. Actually the Verti-Flo design *divides* a horizontal-flow settling tank into a series of smaller, vertical-flow cells.

What does this unique design mean? It means more tank capacity—up to *four* times more than conventional settling tanks. In existing tanks, Verti-Flo will at least double your present capacity. In new construction, Verti-Flo® saves on both construction and equipment costs since you can plan for smaller tanks. Detention times are from one-fourth to one-half those required in conventional tanks and yet you get an effluent of maximum clarity.

Whether you specify equipment or operate a plant, you should know the facts about Rex Verti-Flo. Why not have the advantages of Rex® Verti-Flo in your plant? For complete details, mail the coupon today for your copy of Bulletin 52-77. You'll be happy you did.

These typical Verti-Flo users are getting increased efficiency...lower costs...clearer effluent

Water Treatment Plants

Fairmont, Minnesota
U. S. Penitentiary, McNeil Island, Washington
Ashland, Oregon
Roseburg, Oregon
Kansas State Penitentiary, Lansing, Kansas
Corvallis, Oregon
Florence, Oregon
Valencia, Venezuela
Sweet Home, Oregon
Fort Wayne, Indiana
Belleview, Washington
Washington Water Power Co. Clarkston, Washington
Somerset, Pennsylvania
Federal Reformatory for Women Alderson, West Virginia

Waste Treatment Plants

Pentagon Building Arlington, Virginia
Kirkland, Washington

Industrial Waste Treatment Plants

Johns-Manville Corp. Finderne, New Jersey
Combined Locks Paper Co. Combined Locks, Wis.
Kohler Company Kohler, Wisconsin
Maynard Electric Steel Casting Company Milwaukee, Wisconsin
The Ruberoid Company Bound Brook, New Jersey
Wisconsin Car Wash Co. Milwaukee, Wisconsin

CHAIN BELT COMPANY

Milwaukee 1, Wisconsin

CHAIN Belt Company 56-203
4610 W. Greenfield Ave.
Milwaukee 1, Wis.

Send me my copy of informative Verti-Flo Bulletin No. 52-77.

Name.....
Title.....
Address.....
City..... *State*.....

History is written on water

Great civilizations of the past — Egypt, Persia, Babylonia — waned when their water sources dwindled.

It could happen to us . . . if we let it.

Today, for example. America's thirst for water is beginning to outrun its supply. Industry and homes use more and more water . . . billions of gallons daily.

Yet average annual rainfall does not increase. And erosion of moisture-holding soil continues. What can *you* do?

Several things: encourage your water officials to plan in advance for necessary water facilities. Support realistic water rates and bond issues designed to increase your supply. And conserve where you can.

The hour is late . . . but not past if you will do your part.

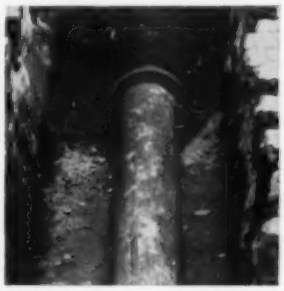
SERVES THE CENTURIES

America's population, productive capacity and national prosperity keep growing.

In more than 64 American cities this upward economic trend is encouraged by an adequate water supply and the cast iron water mains that have carried it so efficiently for a century or more.

Cast iron's longevity and reliability mean continuing, economical service . . . tax dollars saved that can be used to improve service still further.

Rely on Cast Iron Pipe to carry America's Water



Sacramento, Cal. installed this cast iron water main over 100 years ago. It is still doing the job. Yet today's cast iron pipe, modernized and centrifugally cast, is even stronger, more durable.

Longer Lasting Gas Mains

Providence Gas Company laid this cast iron gas main more than 100 years ago. It's still serving.

For more than a century many American utilities have used cast iron gas mains. They have paid for themselves many times over. Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Avenue Chicago 3.

MODERNIZED cast iron

YES . . . History is written on water

WE'RE HELPING ALERT AMERICA TO THAT FACT

We know what an effective job you are doing — satisfying your community's ever-increasing need for water.

We know too that the active support of a thoroughly alerted public is vital to the success of your work.

To help enlist that support, Cast Iron Pipe Research Association is running a series of national advertisements* — *one of which appears opposite.*

By alerting millions of Americans to the danger of our growing scarcity of water, such ads make your job of supplying it easier.

Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3.

CAST Q IRON

The Q-Check stencilled on pipe is the Registered Service Mark of the Cast Iron Pipe Research Association.

*Page ads in 4 national newsweeklies and business publications with 9 million combined readership.

pipe FOR MODERN WATER WORKS

In early July, SMS Plant #3 in Philadelphia began work on these orders. Castings for the valve bodies are shown here in storage prior to machining.

295 R-S BUTTERFLY VALVES IN $2,000,000 ORDER FOR PHILADELPHIA FILTRATION PLANTS

Two large valve orders, totaling some $2,000,000, were recently awarded to S. Morgan Smith and The A. P. Smith Manufacturing Co., of East Orange, N. J. These companies bid the valves for two Philadelphia municipal filtration plants, Queen Lane and Torresdale, as a joint venture.

A total of 295 R-S Rubber-Seated, A.W.W.A. standard Butterfly Valves, in sizes from 24 inches to 60 inches, and 632 gate valves, from 3 inches to 42 inches in diameter, are now being built by the two companies. The Queen Lane valves were purchased and will be installed by Roberts Filter Company and Huffman Wolfe Company, and the Torresdale valves by Ambrose-Augusterfer Company.

You can obtain full information on the complete SMS valve line – Rotovalves, Ball Valves and Butterfly Valves for all water works applications – by contacting our local representative or writing to S. Morgan Smith Company, York, Penna.

HYDRAULIC TURBINES
PUMPS
GATES & HOISTS
TRASH RAKES
LIQUID HEATERS

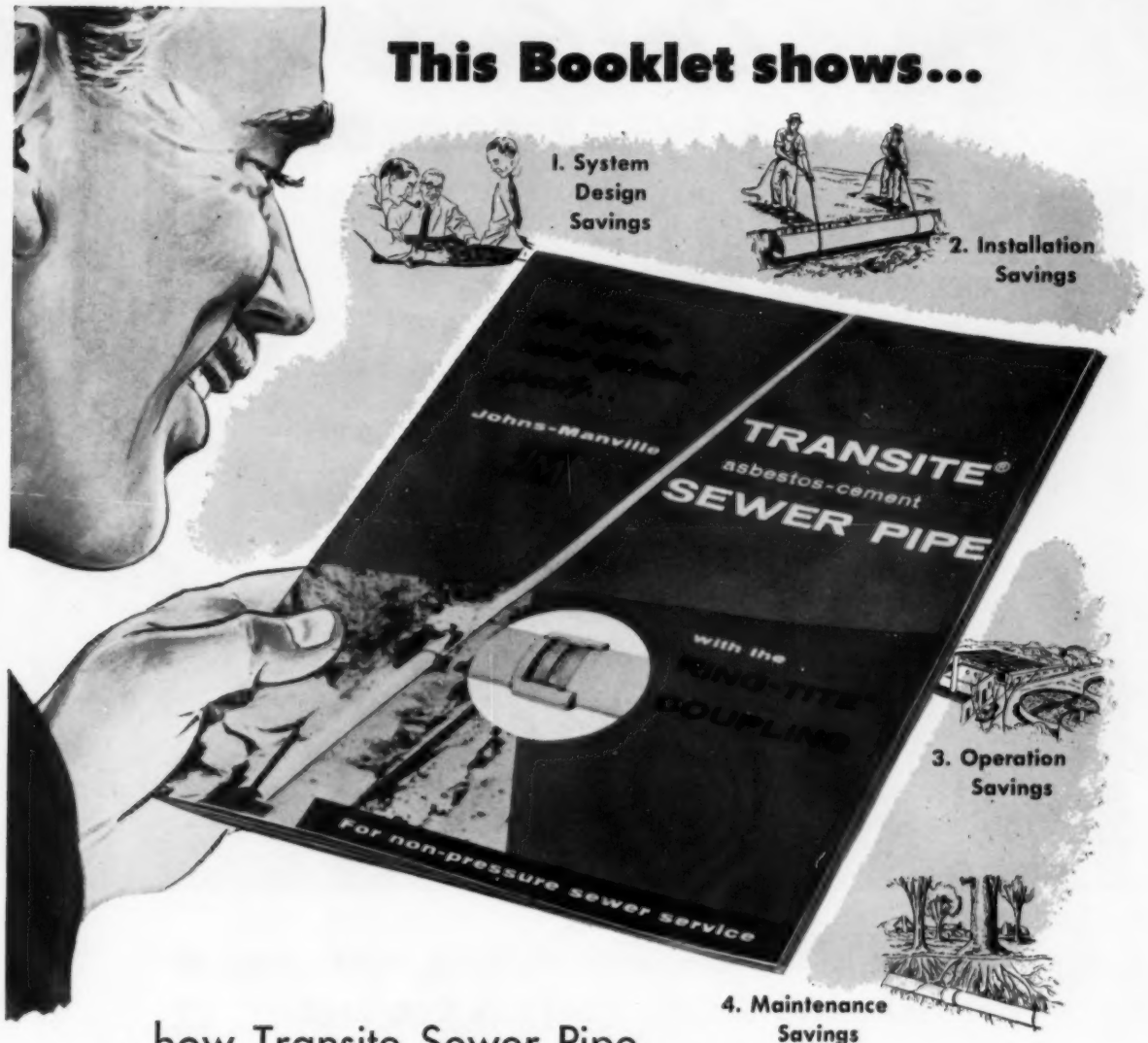
HYDRODYNAMICS

ROTOVALVES
BALL VALVES
BUTTERFLY VALVES
FREE DISCHARGE VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS

SMS

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO



...how Transite Sewer Pipe saves in **4** important ways

Selecting the right pipe material for a new sewage system—or for additions to an existing one—is a problem of major importance to *all* concerned in influencing a choice. *And* it can be solved to *the complete satisfaction of both installer and user* with economies in each of these stages—(1) system design (2) installation (3) operation and (4) maintenance.

Engineers thinking in long-range terms of thoroughly proved sewer main performance . . . contractors interested in serving community needs at new lows in installed cost—both should know all about Transite® Pipe and the Ring-Tite® Coupling. Here is a new booklet that tells and shows how Transite Pipe reduces infiltration, keeps out roots; maintains high flow capacity; speeds installation; permits designing the system for savings. Send the coupon for it today.

Johns-Manville

TRANSITE SEWER PIPE

WITH THE RING-TITE COUPLING

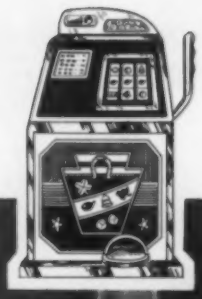
Johns-Manville, Box 14, New York 16, N. Y.

Gentlemen—Please send me your new Transite Sewer Pipe Brochure, TR-165-A.

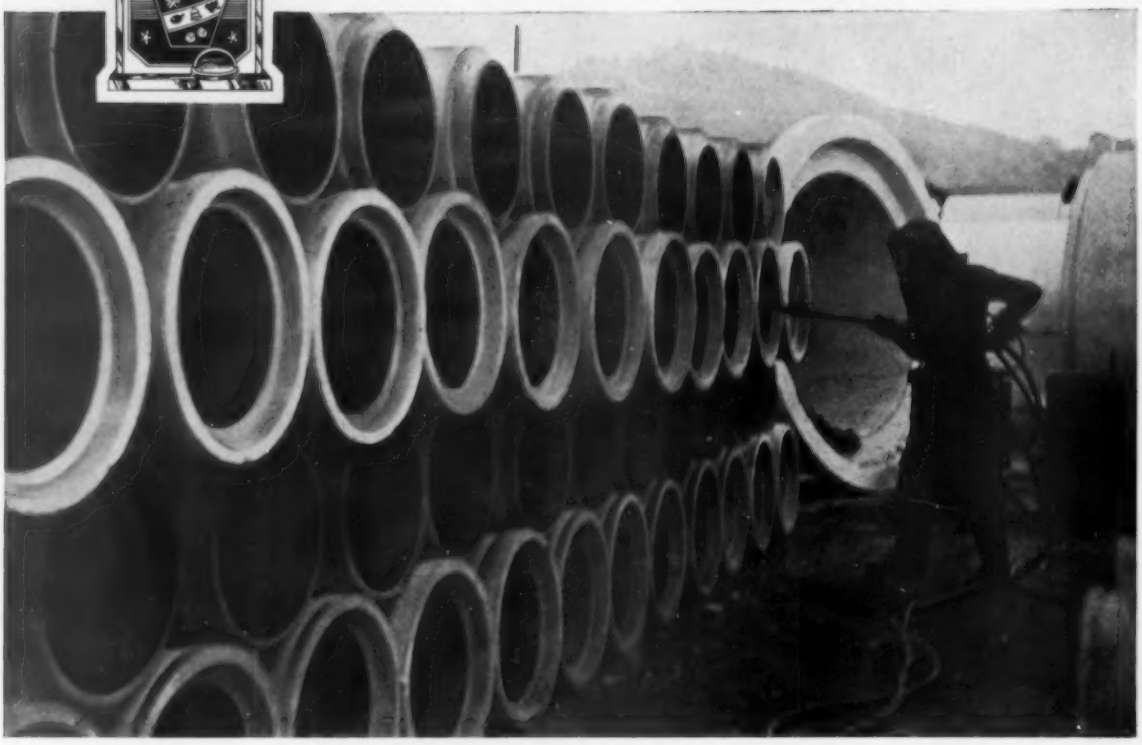
Name_____ Company_____

Street_____

City_____



Don't Gamble with SEWAGE CORROSION!



Invest in the Economical, Sure Protection of PITT CHEM® Coal Tar Coatings

HOW much are *you* going to lose on sewage corrosion this year? If your plant is improperly protected, sewage corrosion is on the job *right now,* silently eating away at your investment in costly structures and equipment.

Why take chances? *Pitt Chem* Cold Applied Tar Base Coatings can stop corrosion in your plant before it starts. These thick, tough, coal tar coatings last far longer than ordinary paints, yet they cost no more per gallon. *No other material does such an outstanding job of protection at so little cost.*

Pitt Chem coatings are easy and economical to apply by brush, roller or spray. They form a tight, lasting, water-proof bond with metal, masonry, concrete or stone. And above all, they *stop* sewage corrosion!

Don't delay! Call for a *Pitt Chem* corrosion engineer today to survey your specific problems. A call, wire or letter will bring his help.

COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

The percentages are right with

INFILCO *High-Rate* SEWAGE TREATMENT

100%.. ..Faster
50%.. ..Less Space
90-95%.. ..B.O.D. Removal

INFILCO'S improved activated-sludge equipment for *high-rate* sewage treatment is the answer to problems of maximum volume from minimum space—highest efficiency at lowest cost.

Complete treatment requires only five to six hours as compared to 10 to 12 hours in conventional plants. Area required is scarcely half as much. Expenses for property, construction, and operation are substantially reduced. And all this without sacrifice in efficiency. Here are typical operating figures from the installation in Collinsville, Okla.—

EFFICIENCY

Date	Ave. Flow MGD	Average B.O.D. Raw Sewage	Average B.O.D. Final Effluent	Average B.O.D. % Removal	Suspended Solids Raw Sewage	Suspended Solids Final Effluent	Suspended Solids % Removal
1/14-2/3, '55	.069	287	21	92.7	335	22	96.5

These figures indicate what can be accomplished in treatment of sewage for institutions or small communities. If you have such a problem, consult INFILCO, because

INFILCO KNOWS HOW to help you solve it.

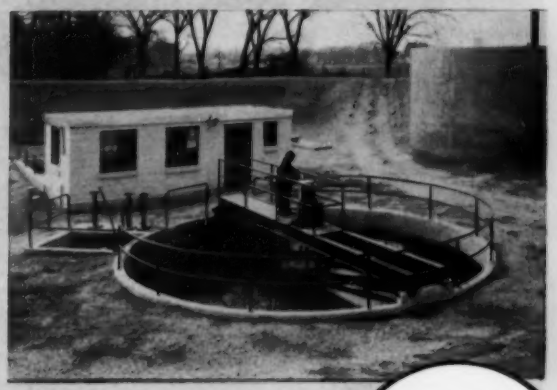
Over 60 years of experience and the most complete and advanced line of equipment are available to you. Write today for full information on the interesting Collinsville installation and Bulletin No. 6550 -WS-26.

Inquiries are also invited on all other water and waste treating problems including coagulation, precipitation, sedimentation, filtration, flotation, aeration, ion exchange and biological processes.

INFILCO

INFILCO INC.
General Offices
Tucson, Arizona
The ONE company offering equipment for ALL types of water and waste treatment.
FIELD OFFICES THROUGHOUT THE UNITED STATES AND IN FOREIGN COUNTRIES

9630

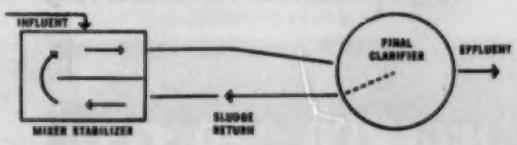


BIOSORPTION® activated-sludge plant for treatment of sewage at Collinsville, Okla.

Consulting Engineers: ***WOOD & CRAIG*** *Tulsa, Okla.*

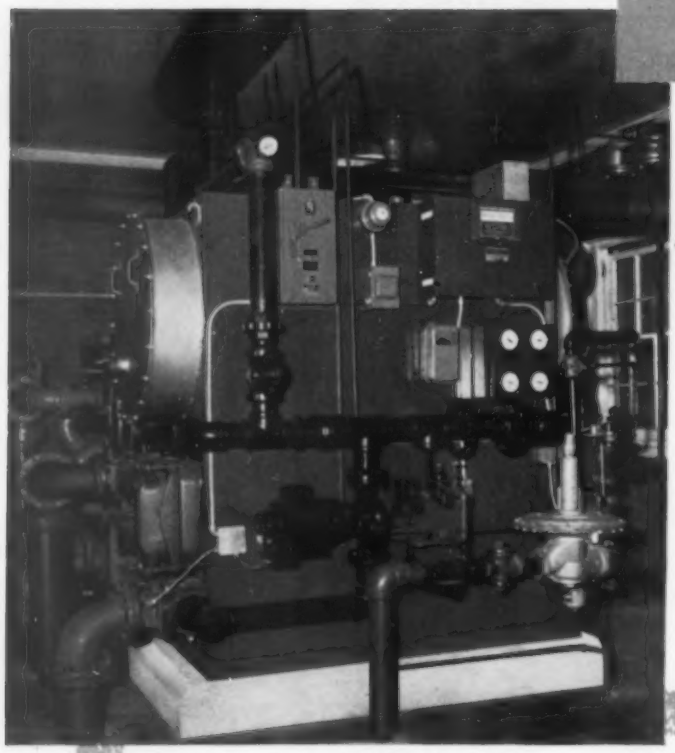
COLAFLEX® diffuser

FLOW DIAGRAM: DESIGN AVERAGE FLOW 0.21 M.G.D.



48 **COLAFLEX®** diffusers in mixer-stabilizer

FLEXIBILITY for your digester sludge heating applications



WALKER PROCESS HEATX

HEATX at Urbana-Champaign, Illinois, Sanitary District rated at 750,000 BTU/hr.

Consulting Engineers-Wilson and Anderson Champaign, Illinois

Mr. E. J. Beatty - Supt. Sanitary District

The complete HEATX assembly consists of control panel, fire tube hot water boiler and tube within a tube heat exchanger. Absolute control of all functions is provided. Boilers are designed to burn either sewage gas, sewage gas and oil or sewage gas and natural gas.
The HEATX is available in standard sizes ranging from 100,000 to 2 million BTU/hr. output. Write for bulletin 24 S 82.

The Walker Process HEATX, for digester sludge heating is designed to provide the most efficient operation; plus flexibility in meeting the requirements of all applications.

For example, the HEATX, in addition to heating sludge at the proper temperature, can readily provide boiler water at a higher temperature for the building heating system. For further efficiency the piping of the HEATX is frequently arranged to permit the unit to utilize jacket cooling water from gasoline engines in the plant's standby power installation.

The boiler water is maintained at 180°, for efficient building heat, while water surrounding the sludge tubes is blended to 140° with thermostatic protection against temperatures where sludge heating demand is less than boiler capacity. Sludge and water velocities up to 4 ft./sec. guarantee high heat transfer coefficients and completely eliminate any danger of sludge caking.

The HEATX is readily adaptable to any installation. Existing plants may utilize present boilers or engine jacket water as a heat source.

WALKER PROCESS

WALKER PROCESS EQUIPMENT INC.

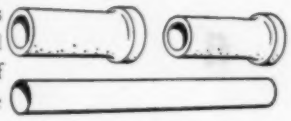
Factory - Engineering Offices - Laboratories

AURORA, ILLINOIS

City officials, engineers, contractors will be interested in these . . .

Facts About Steel Water Pipe

COMPARE THE COSTS . . .

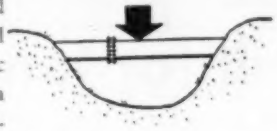


This scale drawing compares a single 40-ft length of steel pipe with two 16-ft lengths of rigid-walled pipe of the same inside diameter. The steel pipe has thinner walls and a smaller outside diameter; weighs only about one-fifth as much per ft of length. Results: the steel pipe costs less to ship and handle; requires a smaller ditch, fewer bell holes, fewer joints—only 132 per mile.

TESTED FOR STRENGTH . . .

Every length of steel pipe is hydrostatically tested at the shop in accordance with AWWA specifications—usually to double the working pressure. What's more, steel pipe is designed to withstand from 3 to 4 times the working pressure! It safely resists water-hammer, shock loadings and surge.

BEAM STRENGTH . . . Steel pipe has the structural strength that is characteristic of tubular steel. It can span long washouts; is often handled in multiple lengths during installation. And steel pipe can stand up under the weight of extremely heavy cover.

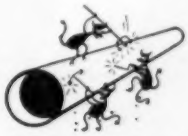


RESILIENCE . . . Steel "gives" under stresses that would cause more rigid materials to crack or break. Steel pipe can "absorb" traffic vibration as well as shock due to explosions and earth tremors. Its resilience allows it to transmit much of the strain to the surrounding earth. This is not true of rigid-walled pipe.

LEAKPROOF JOINTS . . .

100 pct bottle-tight joints are a practical reality with steel pipe, whether Dresser couplings or welds are used. Water leakage is prevented; there's no contamination of the contents due to infiltration from without. These joints are quickly made, they're permanent, and they're strong.

CORROSION-RESIDTANCE



Modern methods of lining steel pipe with hot-spun coal-tar enamel make it immune to corrosion and incrustation. There is no known time limit to this protection. Many tar-enameled lines have been in service for upwards of fifty years. Coal-tar enamel provides the smoothest surface obtainable, assuring high flow coefficients year after year. Coatings and wrappings protect the pipe exterior from moisture, acids and alkalis.

WIDELY USED . . . Large-diameter steel pipe is the growing choice of planners of municipal and industrial water systems. Some recent users of Bethlehem Steel Pipe are: New York City, New Orleans, Philadelphia, Savannah, Reading, Cincinnati, Atlanta, Omaha, Worcester, Colorado Springs and Boston. Further proof of the superior qualities of steel pipe is its use in thousands of miles of large-diameter gas and oil lines, as well as in high-pressure penstocks throughout the world.

If you would like to have further information about steel water pipe, kindly call or write to the Bethlehem sales office nearest you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

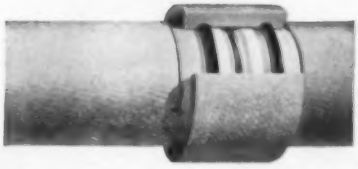
The pipe that's built for tomorrow

K&M "Century"® Asbestos-Cement Pressure Pipe slashes maintenance costs

Over the years, pumping costs are stabilized, maintenance is minimized with K&M "Century" Pressure Pipe. It is non-tuberculating, non-corrosive, non-electrolytic—its bore remains smooth and clean. "Century" Pipe is made of asbestos fiber and portland cement... two practically indestructible materials which assure long life.

And it's lower in initial cost, too! It's light in weight for easy, inexpensive transportation and handling, and even unskilled labor can lay it quickly in any kind of weather.

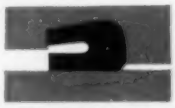
"Century" Pipe can save a community big tax dollars. Write for full information!



NEW K&M "FLUID-TITE"® COUPLING*

Crews can lay more pipe per hour in any kind of weather with K&M "Fluid-Tite" couplings.

**Patent applied for*



Rubber rings compress to allow easy, quick entrance for pipe.

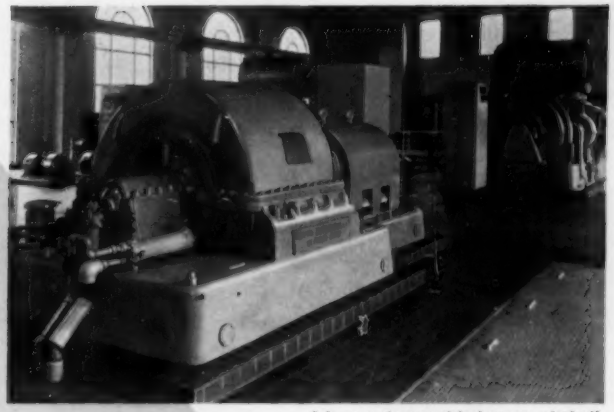
Pressure expands rings. Higher pressure means tighter seal.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

K&M Best in asbestos®

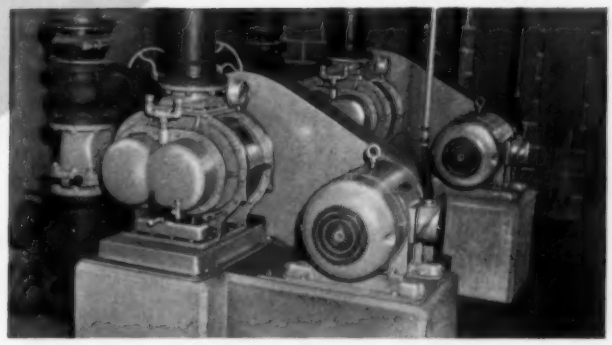
for large city sewage works

or small industrial waste treatment plants



A large eastern municipal sewage plant utilizes a 3-stage R-C Centrifugal Blower with 16,600 cfm capacity and three Rotary Positive Blowers developing from 10,000 to 13,000 cfm each, all direct connected to electric motors.

Two R-C Rotary Positive Blowers, each rated at 530 cfm, assure adequate capacity for waste treatment at the laboratory of a midwestern pharmaceutical company.



R-C blowers assure four basic benefits

From long experience, engineers and plant operating men know they can count on outstanding performance from every Roots-Connersville Blower.

- **Capacities are closely matched to the amount of flow.**
- **Drives are as flexible as desired to meet operating requirements.**
- **Almost complete freedom from downtime and maintenance.**
- **First cost plus long time operating economy satisfy strict budgeting.**

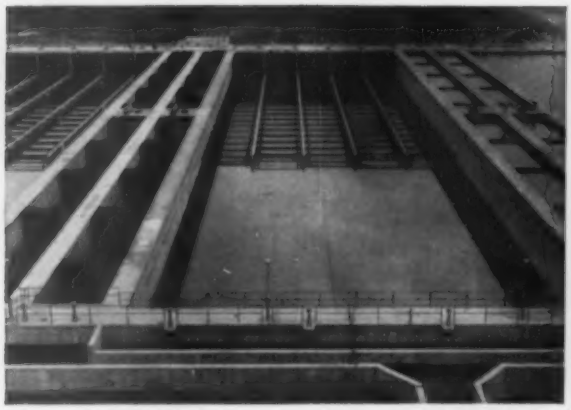
And, as an extra advantage, there is a choice of Rotary Positive or Centrifugal units, depending on the work to be done.

For any waste treatment application, whether municipally owned or privately operated, Roots-Connersville blowers, meters and pumps pay off in performance year after year. Experienced R-C engineering service for additions to existing plants as well as for new installations is yours for the asking.

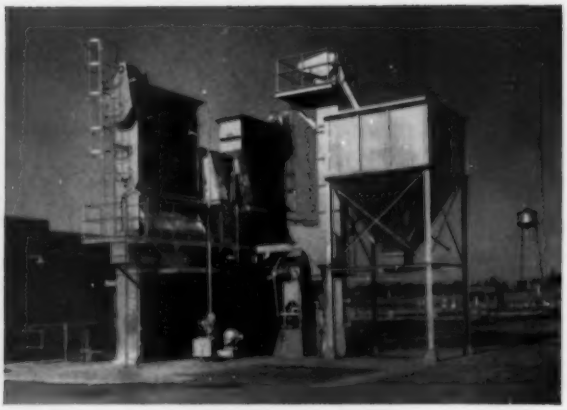
ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

956 Mount Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto, Ont.



Jeffrey Floctrols and Sludge Collectors at Big Walnut Filtration Plant, Columbus, Ohio, where Jeffrey also installed Traveling Water Screens, a Bar Screen and Spiral Conveyors.



The White Rock Sewage Treatment Plant at Dallas, Texas has Jeffrey Grit Collectors and Grit Washer, Screens and Screenings Grinder; also Sludge Collectors and Skimmers not shown in this photo.

HERE'S HELP ON SANITATION PROBLEMS

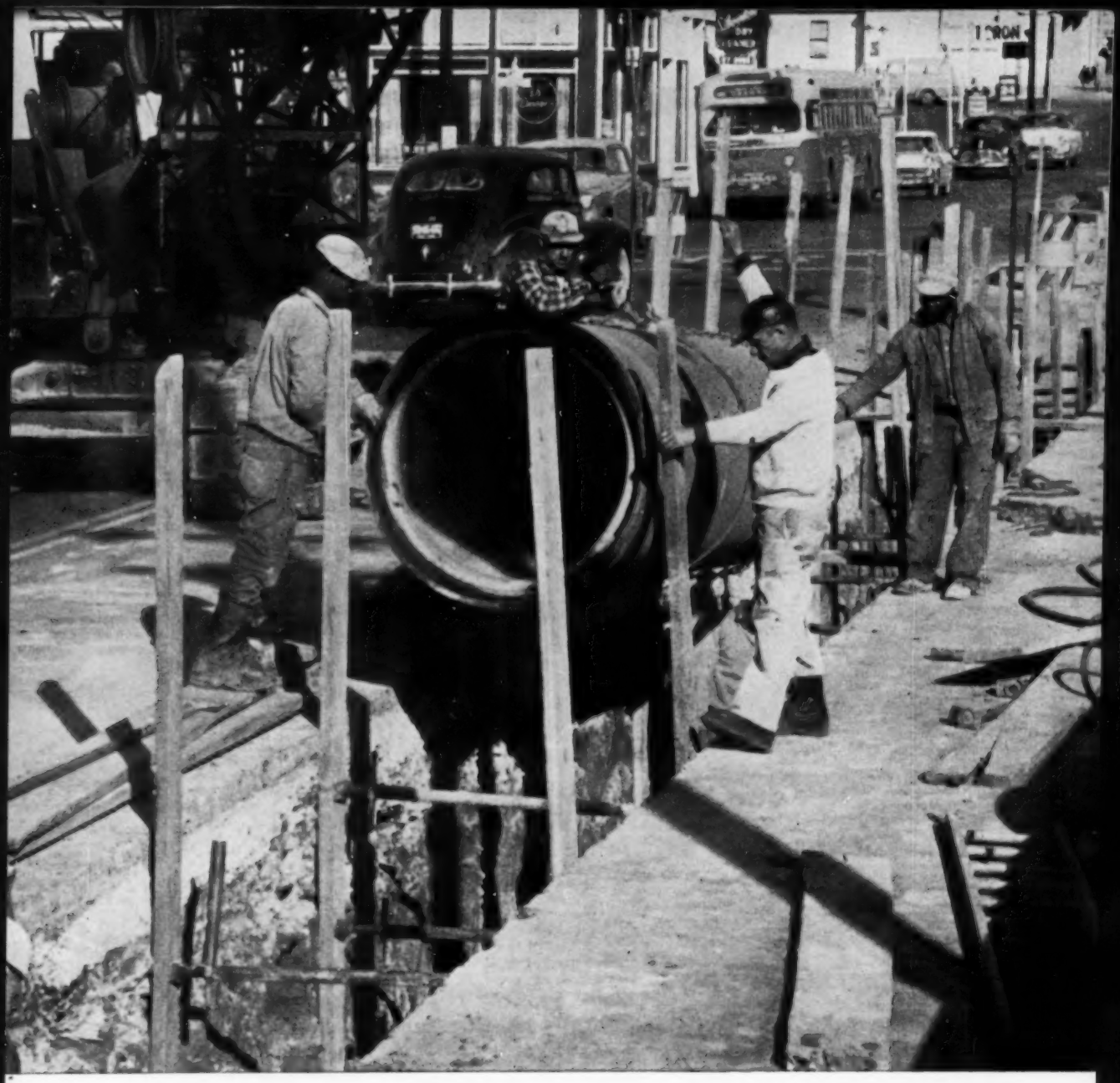
Hundreds of water, sewage and industrial waste plants are now Jeffrey-equipped. Experienced Jeffrey engineers offer assistance on *your* sanitation problems. The complete Jeffrey line for treatment plants includes:

Apron, Belt, Spiral Conveyors
Bar and Disc Type Screens
Biofiltration Plant Equipment
Bucket Elevators
Chains and Sprockets
Dry Chemical Feeders
FLOCTROLS
Garbage Grinders
Grit Collectors and Washers
Power Transmission Machinery
Rapid Mixers
Screenings Grinders
Scum Removers
Sludge Collectors
Sludge Elevators
Traveling Water Screens

These products and their applications are described in a new Catalog 905. For a copy, write to the Sanitation Sales Division, The Jeffrey Manufacturing Company, Columbus 16, Ohio.

MINING • CONVEYING • PROCESSING EQUIPMENT
TRANSMISSION MACHINERY • CONTRACT MANUFACTURING

JEFFREY



Price

Concrete Pipe for Cincinnati's Montgomery Road

Montgomery Road is a main artery that feeds into Cincinnati from the northeast. It carries a heavy load of traffic, so when an extension of a 36-inch water supply line was planned, ease of installation was an important consideration.

Prestressed concrete cylinder pipe turned out to be a happy choice. The job went smoothly for the contractor, A. F. Jelen & Son Co., and the highway was kept open to traffic even through congested districts like the one in the picture. Basic reason was the steel-and-rubber joint which is made quickly and easily . . . and incidentally makes a bottletight, yet flexible joint that is designed to take heavy traffic loads.

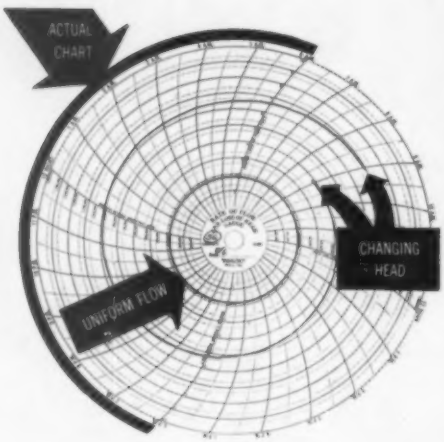
The line is 11,000 feet long and includes both 30 and 36-inch pipe. Along with 620 standard 16-foot lengths, the contractor installed 16 bends, 2 wyes, 3 reducers, 3 tees, 2 closure assemblies, one cross, and a number of short lengths and bevel adapters.

For information on any type of concrete pressure pipe for either water supply or pressure sewer lines, write Price Brothers Company, Dayton, Ohio.

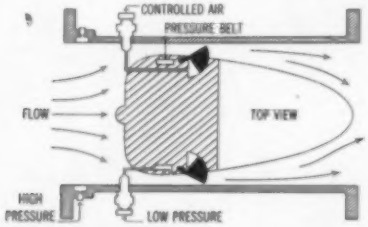
(Advertisement)

NEW SIMPLEX FILTER RATE CONTROLLER GIVES YOU COMPLETELY PNEUMATIC CONTROL!

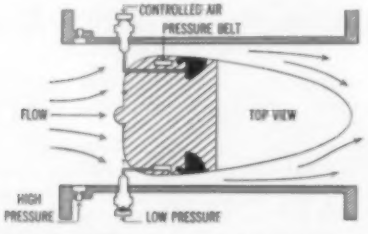
Amazing Modulair® Controller responds fast . . . closes tight



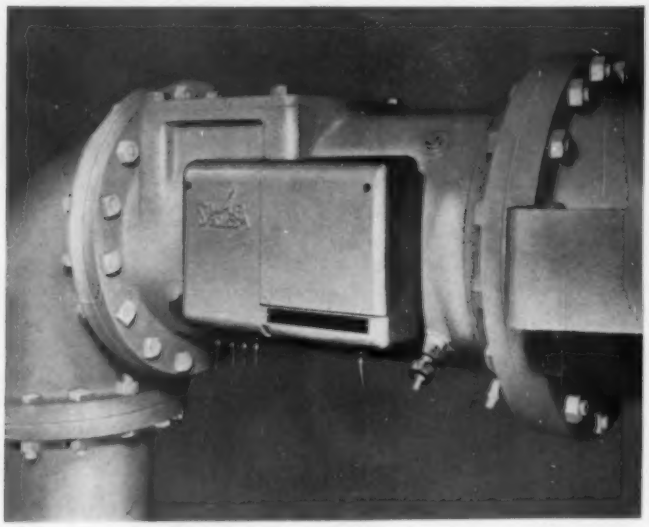
Here's proof that the new Simplex Modulair Filter Rate Controller responds instantly to changes in filter head, holds flow at desired rate . . . automatically! In chart from Modulair installation No. 2, head changes from 4′ to 7′ while rate forms almost perfect circle at the set 275,000 gpd.



How Modulair works! Pipe-like casting with annular Venturi throat houses streamlined inner body with corded-rubber modulator (black) that expands and retracts pneumatically to control flow. When head is low at start of run, modulator expands automatically to hold flow at set rate.



As filter head loss rises, flow tends to decrease . . . and change the Venturi differential. Sensitive Modulair compensates by instantly retracting the pneumatic modulator, maintaining a constant head-loss value through the combined filter and controller, automatically keeping flow at set rate!



Compact . . . easily installed Modulair is only two to three pipe diameters long! It fits wherever a piece of pipe can fit . . . in any position, horizontal or vertical . . . simplifying pipe gallery layout. High-grade, cast iron Modulair comes in 4″ to 24″ standard pipe sizes with corrosion-resisting fittings. Cord-inserted rubber throttling element that's as tough as a truck tire has given 30 years' wear in accelerated life-tests.

Accuracy! In 4 years of field performance, Modulair charts show an accuracy in filter control that exceeds today's most exacting demands. This high degree of control extends for wide ranges of head loss and flow rates, including complete, tight shut-off! And there's no drift at end of run.

Longer filter runs! Modulair combines a low head-loss, annular Venturi measuring element with a streamlined throttling element. This new design offers so little resistance to flow that you get longer filter runs, big savings in wash water!

Minimize maintenance! With Modulair's new design, there's no place for air to accumulate . . . no place for sand to lodge and interfere with accuracy. Throttling element, the only moving part inside pipeline, is non-corrosive rubber. Pneumatic poise element is simple, rugged. There are no line valves, no pilot valves, no pistons, no valve shafts, no stuffing boxes to pack!

Lower first cost! Modulair's low head loss means lower operating head requirements . . . permits vertical compression in plant design and lower costs in plant construction.

Completely pneumatic! No intermediate hydraulic steps! No pilot valves! No hydraulic cylinders! Air loading pressure is applied *directly* to the flow controlling element.

Automatic filter operation! Modulair works with control systems of any type to give you remote rate control or master pneumatic control that's fully automatic.

Technical bulletin! For full details on Modulair, write for Bulletin 950. Simplex Valve & Meter Company, Dept. S-9, 7 East Orange Street, Lancaster, Penna.

Accurate instruments and controls for over 50 years

SIMPLEX®

VALVE AND METER COMPANY

MUELLER®

add gate valves without shutdown

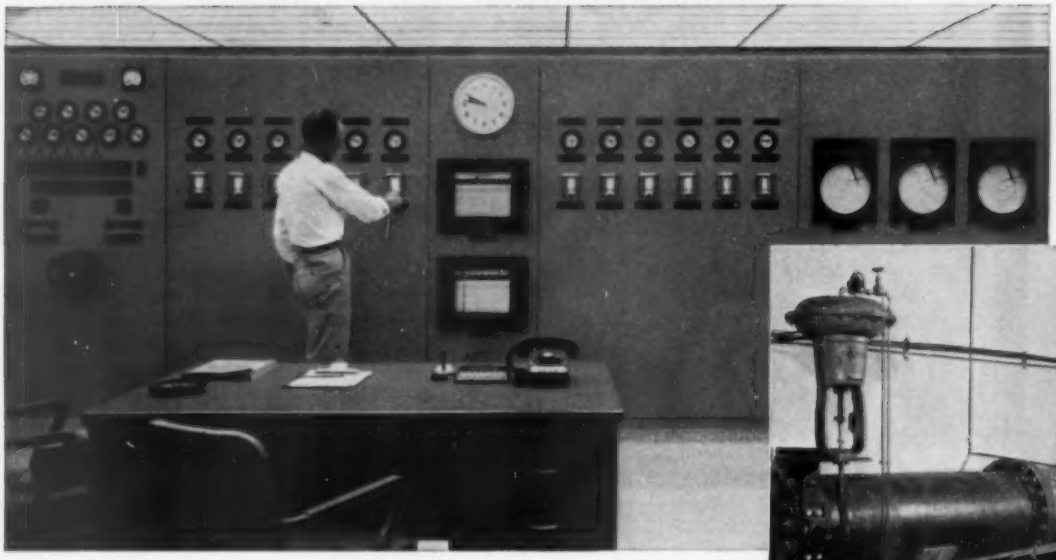
It is a simple matter to replace inoperable valves or to add needed control at vital points in your water system. The Mueller H-800 Inserting Valve may be installed in any existing line under pressure. Flow through the main is not interrupted and there is no loss of water. Gate valve mechanism is identical to Mueller A. W. W. A. standard gate valves with interchangeable parts. Once installed in line, valve is operated like an ordinary gate valve.

Write for the "how to do it" story on Mueller Inserting Valves. It gives a simple step by step procedure for making the installation under pressure.

MUELLER CO.

Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS



***Filter house control panel** puts complete control of this 48-mgd plant in the hands of one man. The plant was designed by Reagan and McCaughan, Consulting Engineers, Corpus Christi.*

***In the pipe gallery,** these Honeywell Mercuryless **Differential Converter** pneumatic transmitters measure loss of head and filter effluent flow. Remotely set Honeywell diaphragm actuators position butterfly valves to hold desired filtering rate.*

One man controls 48-mgd through 12 filters at new Corpus Christi plant

. . . using Honeywell *Filtermatic** System

CENTRALIZED instrumentation, incorporating a Honeywell *Filtermatic* control system, increases efficiency and cuts supervisory work load at the new O. N. Stevens Water Filtration Plant at Corpus Christi, Texas. At his instrument panel, a single operator can see everything he needs to know about the functioning of 12 filters that treat 48 million gallons of water daily. All filtering controls are right at his finger tips. During backwashing, valves are positioned and flow rates adjusted from individual filter consoles. There's never any need to go down to pipe galleries to operate this plant.

Tel-O-Set miniature indicators which show rate of flow through each filter, permit individual adjustments of filtering rate set points, and provide continuous indication of filtering rate and desired filtering rate. In addition, a 12-point *ElectroniK* instrument records all these flow values on a single wide chart. Loss of head for each filter, indicated by individual dial gages, is recorded by another 12-point *ElectroniK* instrument. There are also recorders for clearwell level, wash water tank level, plant effluent main pressure, plant effluent flow, and wash water flow.

Honeywell service on this installation covered not only application engineering of the control system, but also complete fabrication, piping and wiring of panels in Honeywell's Houston service shop. This complete service lowers construction and installation costs, and assures adherence to construction and startup schedules.

A Honeywell field engineer will be glad to talk over your filter plant control, with you and your consulting engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Phila. 44, Pa.—in Canada, Toronto 17, Ontario.

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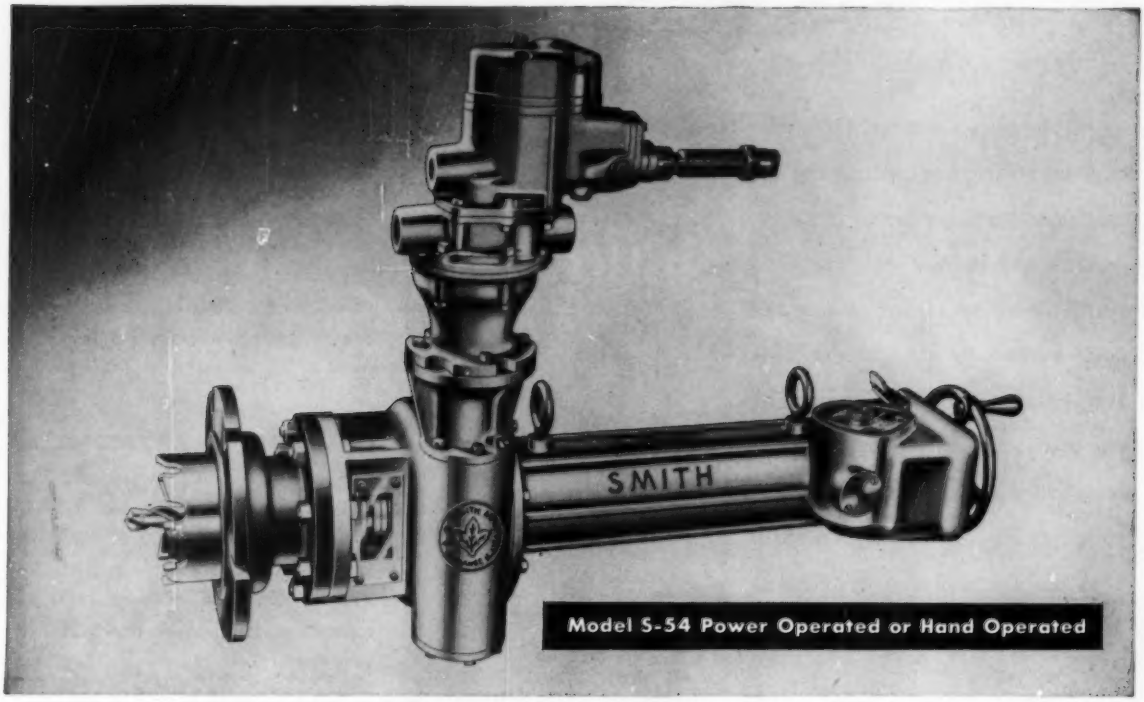

The A. P. Smith Mfg. Company in 1896 introduced the first Tapping Machine for making connections sizes 2″ and larger to fluid and gas service piping under pressure. The *NEW* Smith S-54 Tapping Machine is the most modern, efficient and economical machine available. The S-54 Smith Tapping Machine is used with Tapping Sleeves, Hat Flanges, Saddles and Tapping Valves to make 2″ through 12″ connections under pressure to Cast Iron, Cement-Asbestos, Steel and Reinforced Concrete Pressure pipe. 1. AUTOMATIC FEED: Positive automatic feed insures correct drilling and tapping rate. Hand feed is provided to rapidly advance and withdraw Cutter. 2. TRAVEL INDICATOR: Chart attached to machine indicates travel required to complete tap. Travel is *AUTOMATICALLY* terminated when tap is completed. Cutter and shaft cannot overtravel. 3. COMPACT CONSTRUCTION: Telescopic shaft reduces overall length. 25″ travel is adequate for 2″ through 12″ taps to any size of pipe. 4. ENCLOSED CONSTRUCTION: Mechanism is housed in heat treated Aluminum Case filled with lubricant. Foreign matter cannot enter and damage mechanism. 5. STUFFING BOX AND PACKING GLAND: Accessible without disassembling machine. Equipped with Chevron packing. Line pressure cannot enter machine case. 6. RUGGED CONSTRUCTION: Extra large diameter telescopic shaft adds strength and rigidity. Timken radial—thrust bearings maintain alignment, reduce friction and wear. 7. DRIVING GEARS: Worm gearing operates in lubricant, torque is reduced to the minimum. 8. CUTTERS: Have replaceable Flat and Semi-V alternate teeth of High Speed Steel or Tungsten Carbide. 9. FLEXIBILITY: Hand Operated Machines can be converted to Power Operation by interchanging worm gearing. 10. AIR MOTOR: The motor attaches directly to the Power Operated Machine without Brackets, Holders, Adapters or Couplings. Bulletin sent on request.

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THE A.P. SMITH MFG. CO.

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TENNESSEE CORPORATION

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FERRIC SULFATE

The Superior COAGULANT With the Plus FACTORS—

1. Excellent Taste and Odor Control
2. Coagulation Over Wide pH Range
3. Rapid Floc Formation
4. Color Removal
5. Bacteria Removal
6. Turbidity Removal
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8. Ease of Operation
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10. Increased Filter Runs

Ferri-Floc gives smoother, more efficient and trouble free operation. Whatever your particular water treatment problem may be, you can depend on Ferri-Floc doing a superior job and doing it efficiently and economically—Ferri-Floc is a free flowing granular salt which can be fed with few modifications through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy handling as well as storage in closed hoppers over long periods of time.

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Efficient coagulation of surface or well water. Effective in lime soda-ash softening. Adaptable to treatment of all industrial applications.

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Ferri-Floc coagulates wastes over wide pH ranges — It provides efficient operation regardless of rapid variations of raw sewage — Is effective for conditioning sludge prior to vacuum filtration or drying on sand beds.

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LIQUID SULFUR DIOXIDE

As an antichlor SO_2 has proven to be very effective in controlling accurately the amount of residual chlorine in water supplied to the distribution system.

The quantity of SO_2 needed to remove chlorine is in the ratio of 0.905 parts of SO_2 for each part of chlorine to be removed or reduced.

For plants operating under conditions where control is difficult, superchlorination and dechlorination with SO_2 is more practical than the "break-point" treatment.

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Long recognized as essential to properly control algae, and other microscopic organisms. Copper Sulfate will control about 90% of the micro-organisms normally encountered in water treatment plants more economically than any other chemical.

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TENNESSEE CORPORATION

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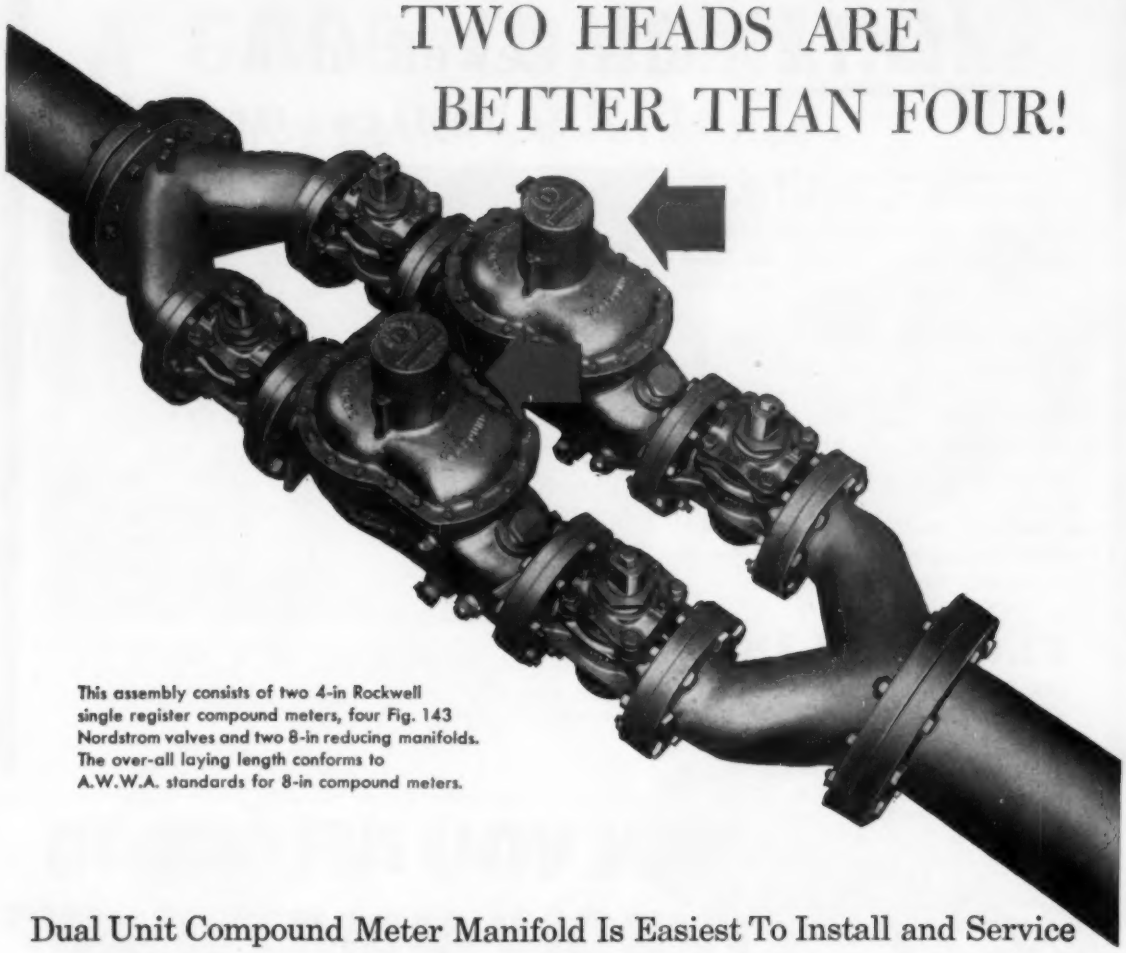
TWO HEADS ARE BETTER THAN FOUR!



This assembly consists of two 4-in Rockwell single register compound meters, four Fig. 143 Nordstrom valves and two 8-in reducing manifolds. The over-all laying length conforms to A.W.W.A. standards for 8-in compound meters.

Dual Unit Compound Meter Manifold Is Easiest To Install and Service

An 8-in compound meter is a heavy, bulky piece of machinery. Installation is always a major problem and service a headache. You'll save time and effort—earn greater revenue by using two-meter Rockwell manifold assemblies. *They measure all the flows* with greater accuracy than a single big compound. And the complete assembly weighs approximately 100 lb less. It only takes *two* men to install.

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A Size and Type For Every Kind of Service

ARCTIC TROPIC TYPE 12 TYPE 14 TYPE 16 TYPE 6 EUREKA B DUAL UNIT COMPOUND

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The SeweRodeR's ability to rod 3,000 to 4,000 feet of sewers per day at a cost of .03 cents per foot naturally impressed Mechanicsburg – but, the "Sale Clincher," was *greater worker safety.*

Rods are self-contained in the SeweRodeR and once the set-up is made, are carried to the sewer pipe inside a guide tube. Operators never touch rods during cleaning operations. Since guide tube is lowered into manhole from street level, 99% of bottom of manhole work is eliminated, with corresponding reduction in exposure to manhole hazards.

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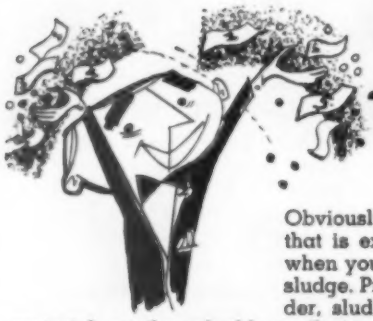

CAN YOU AFFORD TO THROW MONEY AWAY?

Obviously, the answer is "no". But that is exactly what you are doing when you burn or bury your sewage sludge. Prepared with a Royer Shredder, sludge is a valuable fertilizing material, easily saleable to florists, nurserymen, golf courses and gardeners. By making this product available to your community you are doing them a service and at the same time earning a cash return.

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Don't throw money away . . . either by unnecessary disposal costs or by failing to sell a wanted product. Send for Bulletin 55-S giving complete information on the Royer Shredder and its use in sewage sludge disposal.

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for better performance— lower operating costs...

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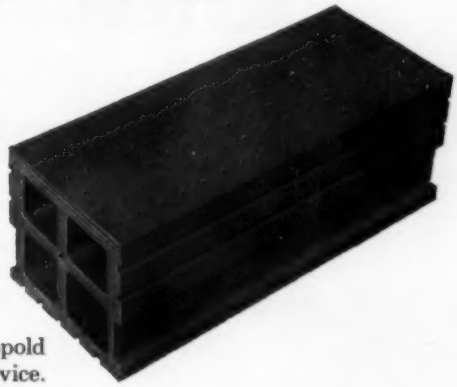
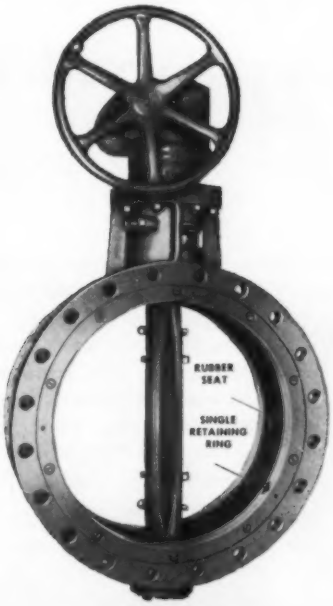
FILTER BOTTOMS



Designed to successfully meet all underdrain requirements

Made of de-aired fire clay—vitrified and salt glazed, the Leopold Filter Bottom is unequalled for dependable, economical service. The individual blocks resist corrosion, are not subject to tuberculation, and will last indefinitely. Too, they require only small sized gravel, do not need special supporting concrete members, and the Leopold design insures uniform wash distribution.



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Rubber Seated
BUTTERFLY VALVES

Assure positive drop-tight shut-off easily, efficiently, economically.

In this design, the seat is of resilient Neoprene rubber or pure gum rubber, vulcanized around a steel ring insert, and held in place by a keeper ring. The steel ring, which is "continuous" to eliminate abnormal wearing, increases the firmness of the seat and assures longer service life.

Whether operated manually or by automatic controls, Leopold Butterfly Valves always provide a positive shut-off that's bubble-tight. Made in sizes 6″ to 72″.

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Trident meters are built to hold accuracy longer, so you receive all the revenue you should. They're built to be easier to repair, so your shop time and expenses are cut down. They're designed so that the newest parts fit the oldest meters . . . simplifying your repair parts problem, helping you to get accurate, thoroughly modern performance from your oldest meters.

For more than 50 years, Neptune has built fine meters designed to earn more and cost less. Many 50-year-old Tridents are still in service . . . perhaps in your own community . . . living proof that the Tridents you buy today will be a credit to your water system for many long years to come.

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WATER & SEWAGE WORKS

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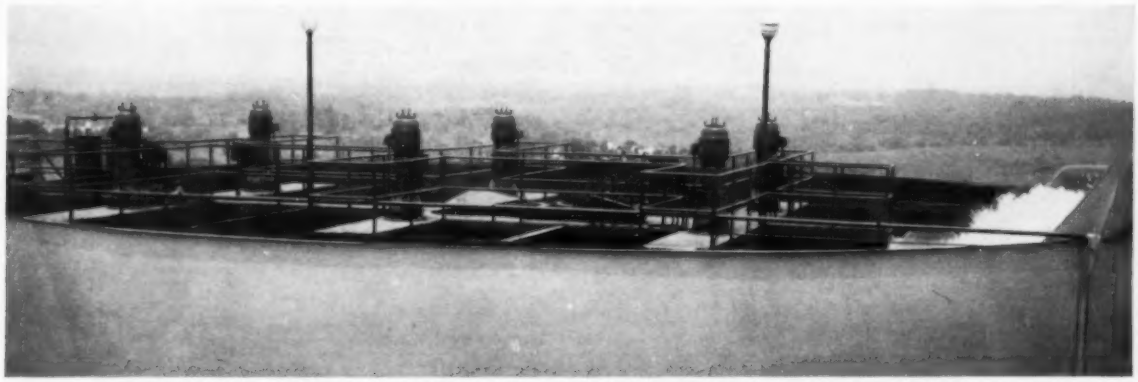


ATOP COLLEGE HILL in Lynchburgh, Va. a filter plant of unusual design incorporates this novel 68 ft. deep flocculating-settling tank.

A Filter Plant That "Grew Up"

In which much is incorporated that is unusual and new, to conserve natural gravity head, and long term, operating economy

by W. MARTIN JOHNSON

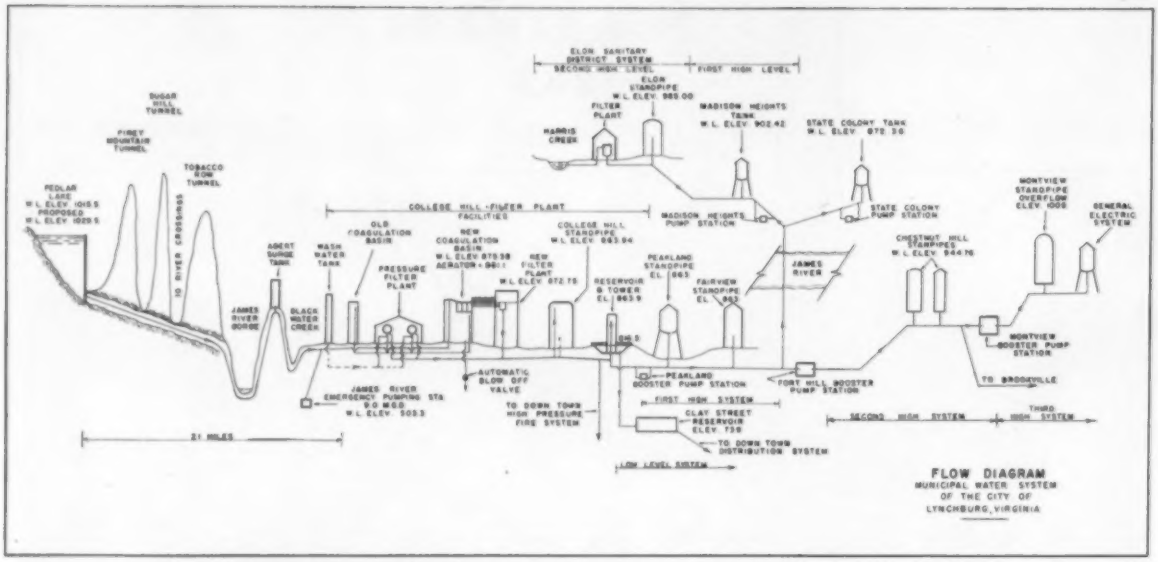
Martin Johnson is a senior partner in Wiley & Wilson Engineers of Lynchburg, Va. Although no relation to the famed explorer of the same name, the readers of this article will realize that he is definitely an "explorer" in the realm of design originality.

JOHN LYNCH, in 1786, operated a ferry where earlier the Monocan Indians had forded the James River at the only shallow quiet water in the river gorge for miles in either direction. Here a community sprung up and became known as Lynchburg. In 1805, the City of Lynchburg, Virginia, was incorporated as a township. By 1823, the population had reached 6,000 and Lynchburg had become a world famous dark tobacco market.

The early inhabitants obtained their individual supplies from springs or wells, while bored logs delivered water to some houses. Civic interest and spirit grew in the thriving town and as early as 1828 a public water supply was actively considered. In 1829 James River water was first made available to houses and businesses by the installation of a pump operated by water power. This pump was located at the foot of Orange Street and water was delivered through a 7 inch cast iron pipe up one of Lynchburg's well known hills to the first reservoir at Seventh and Clay Streets.

The City continued to grow and by 1878 it had expanded eight more blocks up the hill above the James, and a higher level system was required. College Hill Reservoir was constructed, complete with an ornamental iron pitcher cast by the Glamorgan Pipe & Foundry Company of Lynchburg. This interesting antique still pours a stream into the iron railed reservoir.—see picture.

By now the original Clay Street basin was outgrown and obsolete and



FLOW DIAGRAM of the economical gravity water supply system of Lynchburg, Va.

in 1883 the much larger (present) Clay Street Reservoir was also constructed of cut stone, principally of another distinctive local product, Virginia Greenstone.

For almost a century the James River furnished an acceptable supply of water except for an occasional turbid water resulting from erosion of cultivated lands. As civilization opened more land to erosion, and industry added its pollution to the James, the river became too objectionable from the standpoint of color and odor. This problem combined with the westward expansion of the City, which added more pollution of the river above the water supply intake, made it necessary to seek another supply which would be clear and free of pollution.

Although Lynchburg had its origin on the banks of the river at an Indian ford, it has developed as a hilltop community along the ridges instead of inhabiting the valleys, as has been the case in many cities. This circumstance created a situation, requiring either very high head pumping from the James River, and expensive purification, or going some distance to the Blue Ridge Mountains for a gravity supply free of excessive turbidity and no pollution, of consequence.

New Source of Supply

The search for such a supply indicated that Pedlar River, located in the Blue Ridge Mountains in Amherst County across the James River from Lynchburg, could provide for the City's requirements for many years. An excellent site for the dam and impounding basin was found at an elevation which would deliver the water to the College Hill Reservoir wholly by gravity. As usual, the change in supply, at great expense for the distant gravity supply was opposed, but the far sighted City administration ably presented the subject and a bond issue carried in a general referendum in 1904. Construction operations on a 55 ft. concrete dam 415 ft. long was completed in 1907 and the 21 mile aqueduct of 30 inch redwood stave pipe, with steel bands and cast-iron fittings, became an operative supply in September, 1907, when water was delivered to the College Hill Reservoir atop the highest of Lynchburg's seven hills. This gravity supply was to prove more important and economical with each succeeding year as the demand increased for water. Construction of these facilities, with the ten supply line river crossings, was not without its difficulties. Wagons and mules supplied transportation over the access road with its seventeen Pedlar River crossings. Human muscles drove the steel for blasting operations in the three rock cut tunnels and mountainous rock excavation along much of the pipe line.

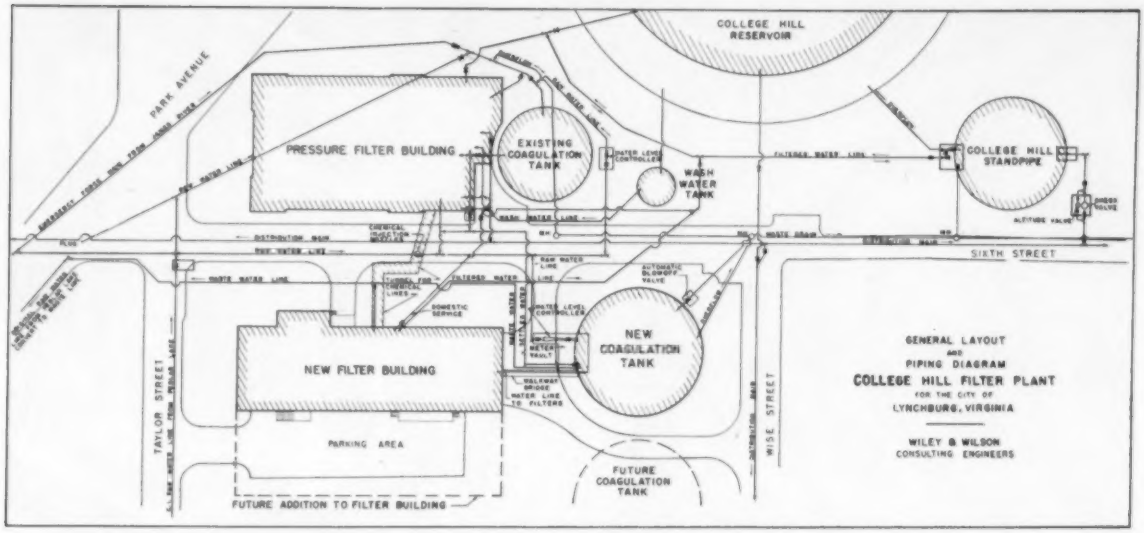
Filtration Provided

While the Pedlar supply comes from a water shed located in what is now principally the George Washington National Forest, covered almost entirely by a heavy stand of hardwood timber, it often became cloudy due to erosion from cultivated fields and by 1917 public sentiment demanded correction of the water quality to maintain the system on a high standard. In 1917 the City Council voted the funds and Wiley & Wilson, Consulting Engineers, of Lynchburg, were retained as consultants for the design of a filter plant having a capacity of 6,000,000 gallons per day. This plant, located alongside of the College Hill Reservoir, was placed in operation in May, 1919.

To conserve the available gravity head from the Pedlar River reservoir, pressure filters of horizontal steel cylinders were used in combination with a deep vertical cylindrical concrete coagulation and setting basin (tank) employing up-flow clarification. This enabled the distribution system to also operate on economical gravity head made possible by the location of source of supply. The pressure filter plant was increased to 8,000,000 gallons per day in 1944. As demands increased, and in preparation for a contemplated filter plant addition, a supplementary coagulation basin (tank) was added in 1953 as the first unit of the overall new water works facilities program.

Records of stream flow have been made since 1904 at the Pedlar Dam. Now, after more than fifty-one years of continuous record, the 38 sq. mile catchment basin has produced an average yield of 21 m.g.d. during this entire period.

With this quantity available by gravity to the filter plant, it is important that this available head be conserved. The dam was first raised 2½ ft., and later 7½ more to 65 feet in height. Present Pedlar River impoundment amounts to more than 600 million gallons. Plans have been com-



GENERAL LAYOUT and piping diagram of the old and the new filter plants of Lynchburg, Va.

pleted by Wiley & Wilson for raising the Pedlar Dam from 65 to 79 ft. in height to increase the storage to one and one-quarter billion gallons.

Where the wood stave pipe was located in rock cuts, and subject to wide varitaion in outside moisture conditions, by the 1920's it was apparent that sections of this pipe would have to be replaced. This was particularly evident in a four mile section immediately below the Piney Mountain tunnel in shale rock cuts. The replacement program was divided into two projects; the first from the Pedlar Dam to the James River an approximate distance of 12.5 miles which section was replaced with 36 inch cast-iron pipe during 1933 and 1934. The second section, from the James River crossing to College Hill, a length of approximately 8.5 miles, was replaced during 1936 and 1937. The pipe and the work was financed by a loan and grant agreement with the Federal Emergency Administration of Public Works.

Until recently it has been the policy to sell water only within the City limits, except for very special cases covered by contracts. Recent industrial developments in and adjacent to the City have caused considerable urgent demand for water. This demand will be met by the City Water Department. The General Electric Company is constructing within the City a plant for the production of rectifiers. The Babcock & Wilcox Company is constructing its nuclear facilities plant a short distance outside the City. As a result of these developments and the changes in City policy regarding outside water sales, the demands on the filter plant and related facilities are already experiencing a rapid increase.

The New Coagulation Basin

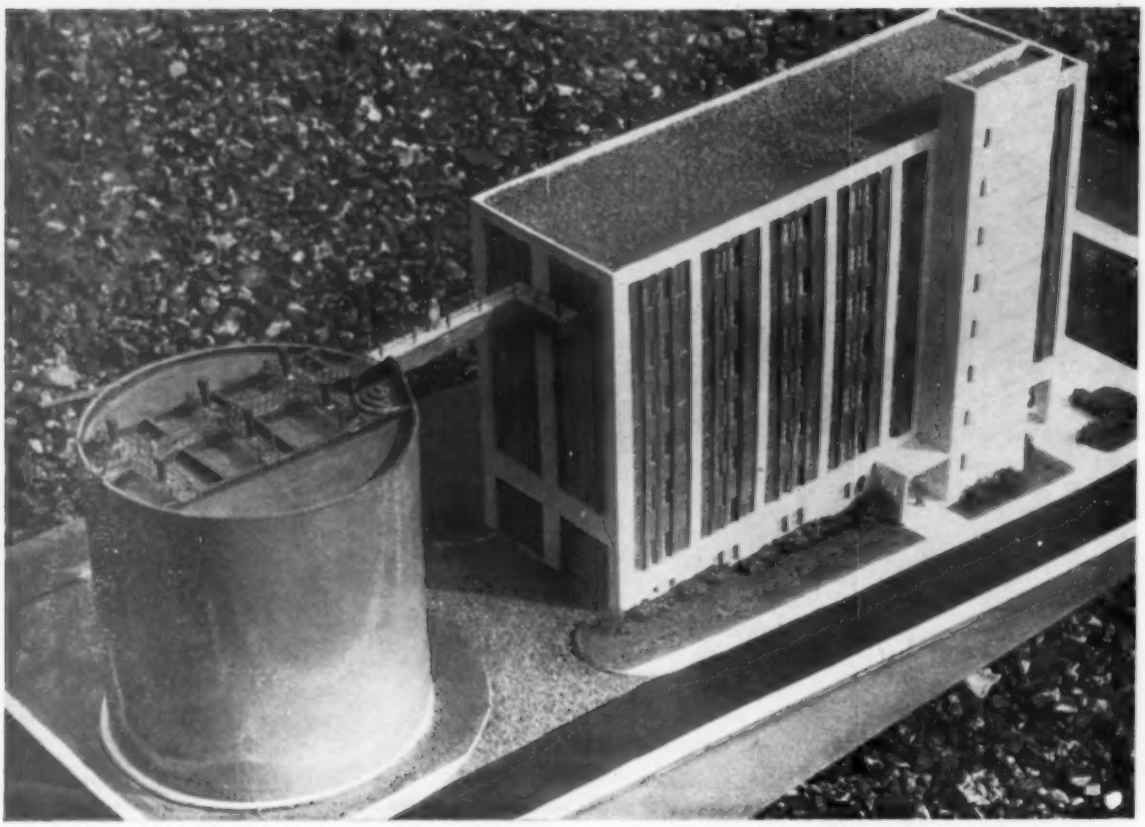
As the water consumption increased towards the 8.0 m.g.d. rate, filter runs became shorter due to the rapid passage through the original coagulation basin. By a preliminary report a long-range plan was outlined, and in 1950 a new coagulation basin was authorized as the first phase of the new facilities construction program.

The new coagulation basin substantially increased the filter runs to about 96 hours on the average, whereas, operating at the peak filter plant capacity; with the original basin in service, filter runs had been reduced to a matter of several hours only.

The new coagulation basin consists of a steel standpipe type tank 72 ft. in diameter by 68 ft. high. Coagulant solutions are injected into the raw water main and distributed therein by means of a flash mixer inserted in the main, after which the water divides to enter the two coagulating basins through a riser pipe extending to the top of the tank. The incoming water overflows at elevation 881.10 and splashes down a series of trough-like steps forming a cascade aerator (see picture) to elevation 875.58, where it enters the mixing and flocculating units. The flow is then divided between two parallel rows of three chambers, each of the six chambers being equipped with vertical paddle mixers driven by variable speed motors. These chambers provide a 45 minute flocculating period. Leaving the flocculating units, the water passes through a downcomer pipe and flows radially under a distributing dome near the floor of the basin. The water then rises sixty odd feet to the peripherial overflow weirs near the top of the tank, with the floc falling out through the rising water —one of the oldest principles in water treatment. From the weir troughs the settled water is returned to the ground for delivery to the old pressure filter plant, but the water to the new filters will be conveyed a short distance through a conduit under the connecting walkway bridge floor directly to the filter valve gallery, rather oddly located on the 6th floor of the filter plant. The coagulation basin has a conical concrete floor and is equipped with a clarifier mechanism 60 ft. in diameter, with a 67 ft. shaft driven from the operating platform at the top of the tank. An automatic electrically operated plug valve blows off the sediment at intervals from the central sludge hopper. The old and new coagulation tanks are operated in parallel, and provide in excess of six hours of up-flow coagulation and settling time.

The Filter Plant

It had been determined by the preliminary report that the filter plant facilities would be added to the College Hill facilities, but across Sixth Street from the existing plant. Since pressure filters were opposed by the



MODEL of Lynchburg's novel seven-story filter plant and settling tank.

(Model by A. G. Foster and photo by H. T. Montiply of the author's staff)

Virginia State Health Department, the first design included a conventional open gravity filter plant involving a four story design, including the clear well, pipe gallery, operating floor chemical storage and feeder floor. However, this design wasted much of the available gravity head and involved instead a total pumping load of approximately 100 ft. head to return the water to the distribution level. At the design rate of seven m.g.d., this meant approximately $42.00 per day power cost for pumping.

Water demands continued to increase, and in 1955 the City Council authorized a new 7.0 mgd. filter plant. When the new plant was authorized, the Water Department was directed to move all its operations from City Hall to the new buildings when completed. Subsequently the joint water and sewer department control laboratory was added to the new plant. Next, it was decided to add the meter testing shop and storage, valve and hydrant repair shop and warehouse, and then the brass goods storage and the garage and shops for Water Department trucks and compressors. All these services, plus the chemical storage and feeders and normal filter operating facilities, together with the clear well, in a conventional type plant, would have occuped a city block in a congested area atop College Hill which was needed for future filter plant expanison. All these requirements for the limited summit of College Hill posed the question of why not expand the plant vertically rather than horizontally. (stand it on end so to speak), and put the filters on the top floor and thereby, would be conserved the virtues of gravity head flow and avoid pumping costs against the 100 ft. of distribution head. Pumping equipment costs, their electrical starting and control equipment, piping and connections, and housing space, together with maintenance costs, could be eliminated by this design. Lynchburg's hilly topography assisted in this upended plan, and so with the various parts and floors required, each fell into its natural position, for by placing the filters on the top floor, the site offered height for six additional floors. It was according to this scheme that the final plans for the new filter plant facilities were developed.

The operating gallery and open filters on the top level correspond with the operating platform of the coagulation basin, to which this floor will have access by a connecting walkway bridge. The "hanging filters" are suspended into the sixth floor space, with the valve gallery occupying the remaining space on this floor. The fifth floor is required for chemical storage and solution vats, with the feeders situated on the fourth floor and the chemical supply hoppers extending up into the fifth floor space. The filter wash water pump and booster pumps for the higher pressure surface-wash supply are also located on the fourth floor. The general Water and Sewer Department laboratories are located on the front section of the same floor. The third floor is all devoted to the meter testing shop, sandblasting, drying and acid booth, and warehouse

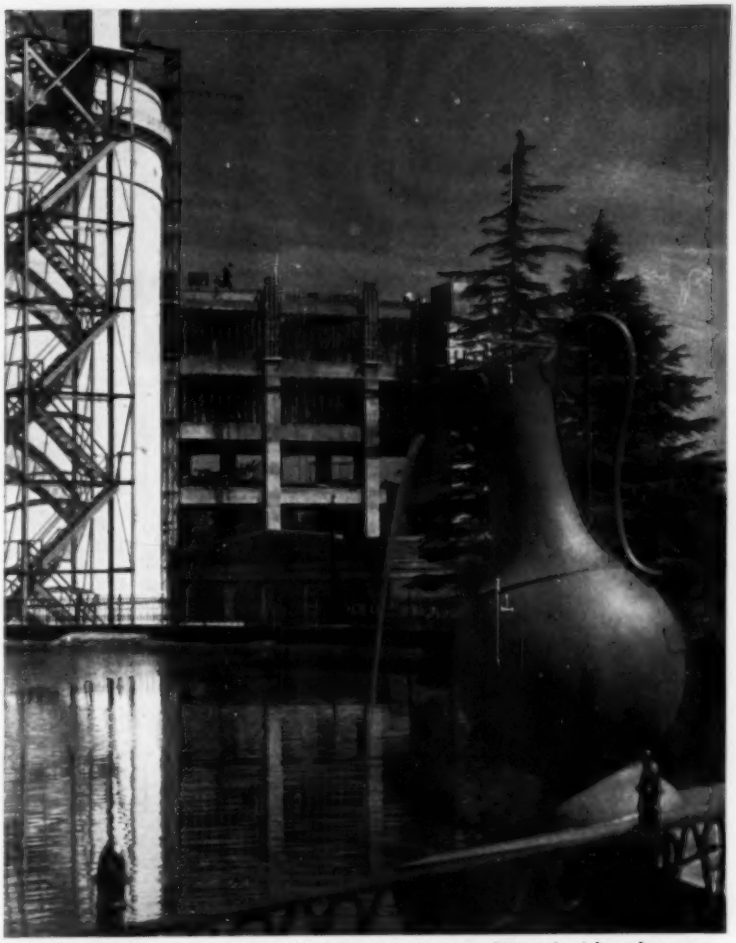
for brass and copper goods and other small water works supplies. Toilets and locker room are located at the front of the second floor. Topography permitted the second floor to have a grade entrance from the rear. This floor will serve as the garage and shops for motor vehicles and compressors, hydrant and valve repairs. Hand tools storage for department personnel, together with the shop foreman's office, occupy the remaining area of the second floor. The first floor serves as the headquarters for the Water Department, with the business offices and that of the Superintendent and his staff located in the front end. This arrangement provides space for an entrance, a public lobby, and cashier's counter where water bills may be paid in person. Billing and collection facilities, bookkeeping, record files, applications for service, and all Water Department business operations will be handled here. The Superintendent's office includes engineering, drafting and storage space adjacent to the public areas. A fireproof security vault is provided for funds, records and drawings. The balance of the first floor is occupied by chlorine storage, a boiler and mechanical equipment room, switchgear room, and transformer vault. The chlorine vault for storage of ton containers has a truck platform height entrance and is equipped with a monorail conveyor for the chlorine containers. The building is served by a commercial type elevator and a stair tower which extends to the roof level. Certain of the structural columns were stubbed off at the roof line to support the steel structure for a future commercial or television tower which the City may lease for commercial broadcasting. Already incorporated in the building is space for the police radio transmission equipment and a transmitter tower which will be mounted atop the penthouse roof of the elevator-stair tower. This location will be the highest elevation within the City limits.

A drive-in tellers window was omitted when arrangements were made for customers who wished to pay their water bills in person to do so at any local bank or branch, or at the City Hall cashier's window, which plan proves to be very acceptable by the public.

Design Features of The New Plant

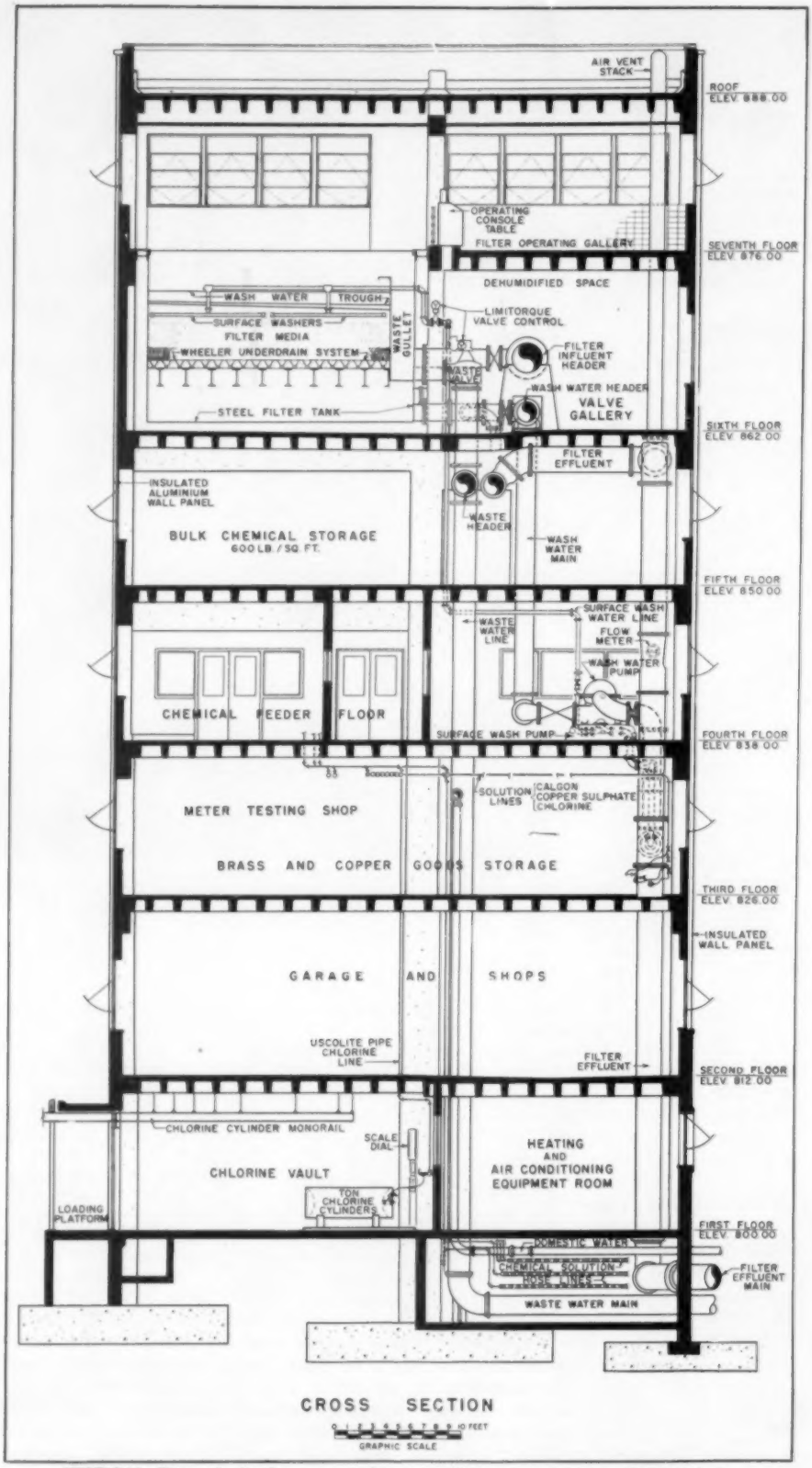
Preliminary designs determined the advisability of using suspended steel tanks for the filter tubs, and reinforced concrete for the building structure. Since modern design of all features was one of the objects of this somewhat radical departure in filter plant design and architecture, contemporary materials were selected as a part of this scheme for the exterior of the plant. The shape and construction of the structure indicated its suitability for pre-fabricated wall sections of light weight. Fluted vertical insulated aluminum wall panels with aluminum window frames, separated by heavy extruded aluminum mullions, were selected for the exterior walls. These panels eliminated 13 inch thick brick walls, and the overall width, as well as length, of the building was thus reduced twenty-two inches. At the same time, this construction eliminated enormous tonnage in dead weight and reduced the sizes of columns and foundation footings. Also, with the aluminum exterior, maintenance is reduced to a minimum. The panel wall sections have sealed insulated wall spaces to improve their thermal efficiency value. The exterior is finished in 3 in. by 2 in. rectangular fluting, adding strength and the appearance of height to the wall construction. The exterior aluminum surface is a frosted finish with scored vertical striations.

With the heavy loads involved and spans desired, due to the size of the filter tubs, pan type concrete beam construction was used for floors and roof. Exterior surfaces not covered by insulated wall panels are of rubbed architectural concrete. Quarry tile is used for the seventh floor filter operating gallery, laboratory and toilets. Rubber tile is used for the public lob-

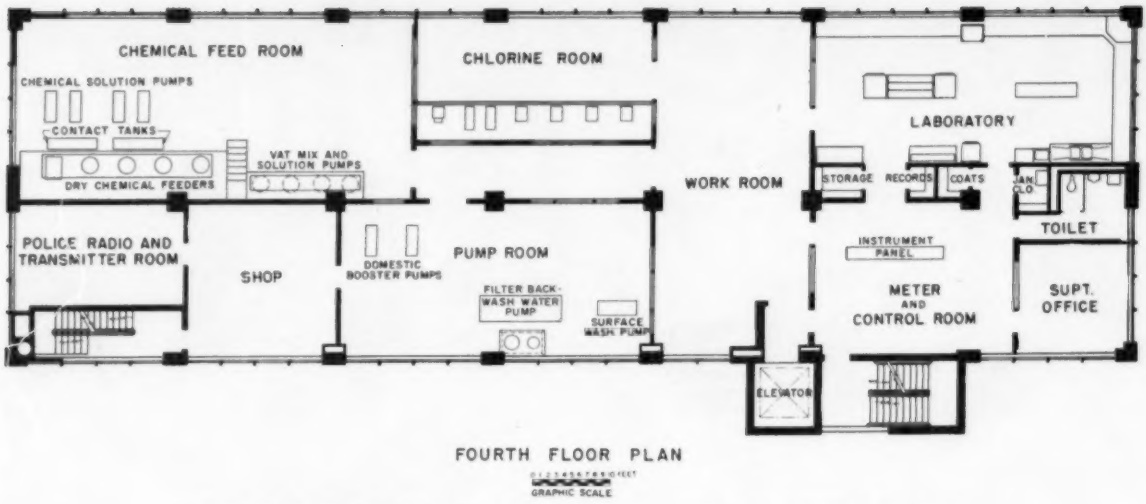


(1878-1956) Across College Hill Reservoir the new filter plant is going up. The low brick building houses the pressure filters, operating since 1919 under head afforded by the concrete settling tower on left.

(The now historic cast-iron pitcher, that never runs dry, was cast by the Glamorgan Pipe & Foundry Co. in 1880)



VERTICAL filter plant of seven stories, revealing arrangement and operations on the seven floors.



FLOOR PLAN revealing centrallized operating arrangements at the fourth floor level.

by, and asphalt tile for the office floors. Ceramic tile is used for the lobby walls and exterior covered and interior vestibule entrance areas. Salt glazed tile wall finishes are used in all toilets and the fourth floor laboratory and office spaces. Public spaces, Water Department general offices, and the laboratory are air conditioned.

The pipe gallery in which the filter tubs are located is sealed, and

LYNCHBURG'S novel Water Department Building, as the artist sees it.
Offices and shops on lower floors; filter plant on upper floors.

MOTOR DRIVES on mixing and flocculating chambers within the deep up-flow settling tower connected by short bridge to filter operating floor.

(Note effective cascade aerator in background and the city of Lynchburg beyond)

openings are weather-stripped to prevent the entrance of moisture. This space is dehumidified by supplying to it only dry air. With the use of the electric valve controls, packing gland leakage is reduced to a minimum, while, at the same time, moisture is eliminated from the electric controls' moving parts by the dehumidified air. Maintenance of the painted metal surface is expected to be reduced to a minimum.

Future expansion of the plant will be accomplished by placing the additional facilities backed up to this first battery of seven filters. Expansion of filter facilities will likely demand similar expansion of all other plant services. It is planned to continue the pressure filter plant in operation and replace filter shells if or when necessary. These units have been maintained in first-class condition, and none of the 37 year old filter shells have been replaced to date.

The structural design of the plant allows for stresses due to two degree earthquake shocks.

In order to reduce the head room required on the sixth floor by several feet, it was decided to use the electrically operated valves instead of the conventional hydraulic cylinders. Valve control panels are located on the operating table consoles in front of each filter.

Treatment

The Pedlar River reservoir is the normal source of Lynchburg's water supply, but an emergency supply of 9.0 m.g.d. is provided from the James River, which may have widely variable characteristics. The Pedlar supply is very soft, containing an average of approximately 11 ppm hardness. The proposed treatment will consist of pre and post chlorination. Coagulants normally used are aluminum sulphate and soda ash. Activated silica will be used when organic color is high in the lake water. Post treatment for stabilization will be obtained with lime or soda ash and "Calgon," depending upon distribution system sample test requirements. Activated carbon will be used for taste and odor control of the treated water. Fluoride application is also provided at present, using sodium silico fluoride. Lynchburg was one of the first cities in the United States to use this treatment. Pre treatment with copper sulphate is provided for controlling algae growth in the coagulation basin. Pumps will be used to inject the chemical solutions at the effective points of application.

Even with the treatment provided, the filtered water is sufficently low in mineral content to be used directly for storage batteries.

Materials and Equipment

The coagulation stand pipe tank was fabricated by Pittsburgh-Des Moines Steel Company, using United States Steel Corporation plates. Due to the stresses and the thickness of the lower shell plates, the vertical seams were X-rayed. A special assignment of radioactive cobalt was used for the X-ray exposures. This was one of the first uses of this material for commercial purposes, and greatly reduced the exposure time and offered great convenience in the process, due to the much lower weight of the ray-producing source than that of conventional X-ray equipment.

The flocculating unit mechanisms were furnished by Roberts Filter Manufacturing Company. The Dorr-Oliver Company furnished the clarifier mechanism. Speed reducers for the mixers and clarifier mechanism were supplied by Philadelphia Gear Works.

The filter building is being constructed by John P. Pettyjohn Company of Lynchburg as general con-

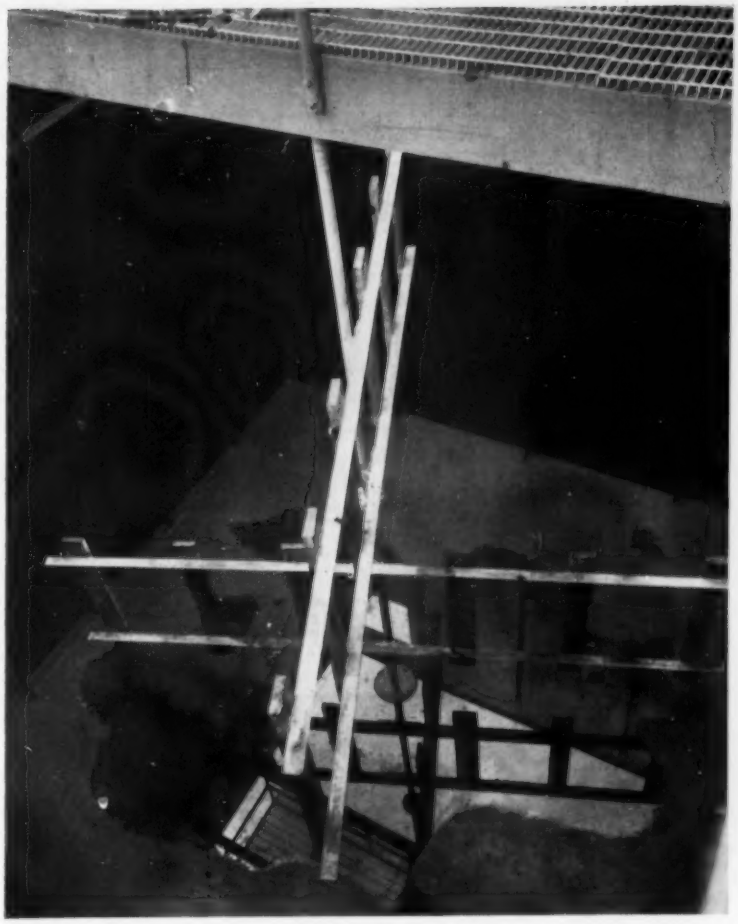
tractor. Aluminum wall panels are H. H. Robertson Company, and glazed aluminum window frames by Cupples Products Company. Robert Filter Manufacturing Company is general contractor for the mechanical equipment, operating table, and for moving and reinstalling existing equipment to be transferred from the old plant. All operations, except the pressure filters, will be transferred to the new building. Chlorinators and other chemical feeders, including the Fluoridator and the activated silica "Silactor", are supplied by Wallace and Tiernan Company.

Square bottom gate valves by Darling Valve Company are used for the filter valves. Butterfly valves for the larger sizes are by Henry Pratt Company. All filter valves and principal main line valves in the plant, and the electrically controlled coagulation basin blow-off plug valve, are operated by Limitorque Valve Controls by Philadelphia Gear Works, and manufactured in their Lynchburg works (Virginia Gear & Machinery Corporation) which is a close neighbor of the filter plant.

Meters, rate-of-flow indicators and controllers, and gages are by Builders Providence, Inc. The steel filter tubs are by Gary Steel Products Corporation of Lynchburg, and are equipped with Wheeler underdrain bottoms. Laboratory furniture is by Technical Furniture, Inc. Surface filter washers are Palmer Filter Sweeps by Fred Stewart Corporation. Electrical control panel is by Penn Instrument Company. Surface wash and filter wash pumps are by Fairbanks Morse Company. Chemical solution pumps are by Durion. Cast iron pipe and fittings are by Lynchburg Foundry Company.

Design

The author developed and engineered the general design and arrangements of the coagulation tower and filter plant. Thomas R. Leachman, A.I.A., handled the architectural design and treatment, with William St. Clair in charge of structural design. Albert R. Doss directed the water piping and mechanical equipment layouts. Electrical design was under the direction of Gilbert M. Peery. Heating, air conditioning and dehumidification was designed by E. J. F. Wilson, Jr. The model of the plant was executed by A. G. Foster.



ONE of the flow mixing-flocculating chambers with variable speed rotating paddles.

Management

Robert D. Morrison is City Manager; Robert D. Wright, Director of the Water Department; and James G. Jones is Superintendent of Filtration.

WATER WORKS IMPROVEMENTS

First Stage

Raw Water Pumping Station, Emergency, 9.0 m.g.d.	$ 68,067.54
Raw Water Pumping Equipment	40,662.68
Mixing Equipment	18,600.00
Sludge Collecting Equipment	8,220.00
Coagulation Basin and College Hill Standpipe	161,335.68
Pipe Connections, Foundations, Meter Room, Grading, etc.	158,062.33
Chestnut Hill Standpipe	29,580.00
Chestnut Hill Booster Station & Tank Foundation	22,910.74
Engineering Planning & Supervision	36,736.07
Total	$ 544,175.04

Second Stage

Construction Costs	$1,082,520.00
*Contingencies	
Engineering & Supervision	73,600.00
Land & Rights of Way	18,000.00
Legal & Administration	1,000.00
Bonds, Printing & Advertising	1,500.00
Total	$1,200,000.00

*Contingencies include daily inspection and sitework such as driveways, walks, landscaping, etc.

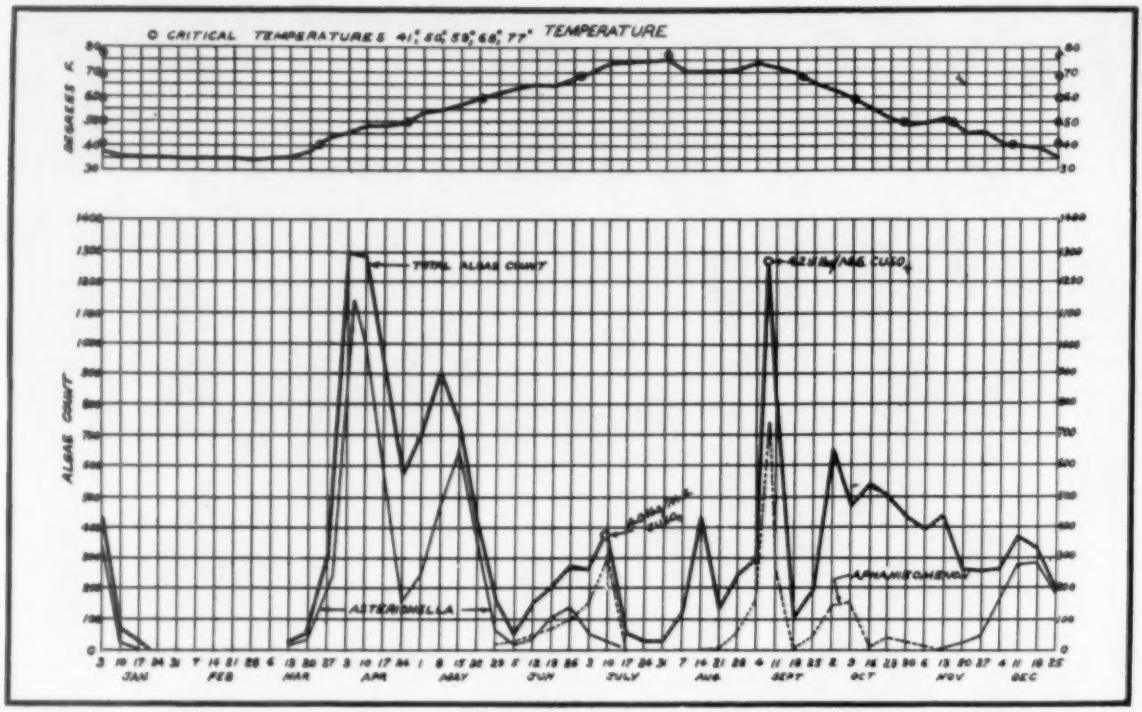


Fig. 1—GRAPH of year's study of algae growths in reservoir

Algae Control With Copper Sulfate

by W. D. MONIE

Mr. Monie is Chief Engineer of The Portland Water District in Portland, Me. In this article he brings up to date a subject with which he is well acquainted and about which he has written before.

ALGAE GROWTHS are one of the principal causes of taste and odor in a water supply. Thus the control of algae growth is important if the customers of a water company are to receive a product of the highest quality.

Other than the objectional features of taste and odor is also the possibility of the effect upon humans of toxic products given off by the disintegration of algae, especially the blue greens. Fitch et al[1] show that cattle and sheep have been killed in numbers within a few hours after drinking water heavily loaded with Anabaena. A study to determine possible effects of disintegation of large numbers of algae in connection with gastro-intestinal outbreaks in late summer would be well worthwhile.

Algae control to be successful must be a preventive measure and not a cure. The removal of algae by treatment at the proper time from the standpoint of economy and before the algae cause objectionable taste or odor is the true science of algae control.

Every problem, regardless of its complexities, is solved by a common sense application of fundamentals. The problem of algae control is no exception, and it is with the common sense application of fundamentals pertaining to this problem that this paper is concerned.

A, B, C, of Algae Control

The three factors most important in algae control with copper sulphate are:

A. The ability to determine when it is necessary to treat a supply.

B. The ability to determine the correct amount of copper sulphate to apply when treating.

C. The ability to apply the treatment so that uniform distribution of the copper sulphate is obtained.

Microscopic Examination

The first step in analysis is the identification of and count of the algae present in a water supply. This step is accomplished through microscopic examination .

For the operator who has not had training in microscopic indentifica-

tion of algae there are many aids. Illustrations of the more common troublesome algae can be found in the 10th Edition of Standard Methods for the Examination of Water, Sewage, and Industrial Waste[2]; Whipple et al[3]; and Algae of Importance in Water Supplies[4].

The most common method of microscopic laboratory analysis is accomplished by the Sedgwick-Rafter method. Laboratory equipment necessary for microscopic examination:

1—microscope
1—Sedgwick-Rafter cell
1—Sedgwick-Rafter cell funnel
1—pound Berkshire sand
12—filter discs
1—500 ml graduated cylinder
1—10 ml transfer pipette
1—1 ml 1/10 Mohrs pipette

In preparing samples for examination by this method, reservoir water is filtered through Berkshire sand, and the sand washed with distilled water. A 1-ml portion of this concentrate is then placed in a rectangular Sedgwick-Rafter cell and examined under a microscope having a magnification of 100X. If an ocular micrometer is furnished, 10 standard units are counted and the total number of organisms in the 10 units comprise the algae count. Without an ocular micrometer, 10 separate fields are counted and totaled. The algae count without the micrometer is about 15 per cent higher than a count in standard units.

For comparison purposes the amount of reservoir sample (usually 500 ml), and the amount of distilled water, (usually 10 ml) used for the concentrate should always be the same for each analysis. If it is desired to convert results to standard units or total count, proceed as outlined, starting on page 455 of "Standard Methods"[2].

Details of the method of concentrating samples by the Sedgwick-Rafter Method are given on page 442 of "Standard Methods"[2].

In making microscopic examination always remember that samples must be collected from the reservoir. If samples are collected from a main or after passage through a pump, delicate organisms are broken up and some become unrecognizable. It must be emphasized that samples for microscopic examination drawn from the mains *are of little value*. For bacteriological examinations such samples are satisfactory, but for organisms larger than bacteria, such samples give a wholly inadequate picture of what is going on in the reservoir.

It is advantageous to obtain samples periodically from different sections of the reservoir. Depth of water, exposure to sunlight, and other factors will cause surprising differences in type and number of algae present in the various sections of the reservoir. An objectional algae may start growth in a shallow area and be the seeding point for the entire supply when conditions for growth become favorable.

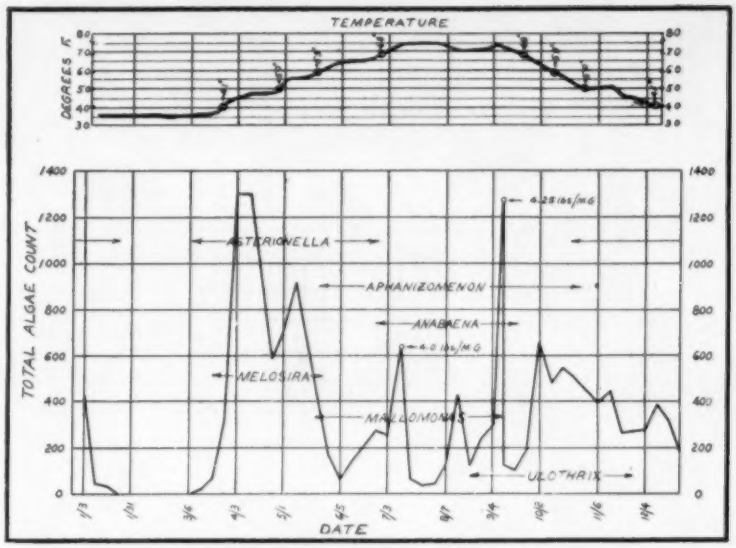


Fig. 2—RECORD of algae growths, types and counts
Reservoir temperature shown in top graph

Importance of Temperature

An important supplement to microscopic examination is a thermometer. The growth of different types of organisms can be anticipated by the temperature of the water, especially surface temperature.

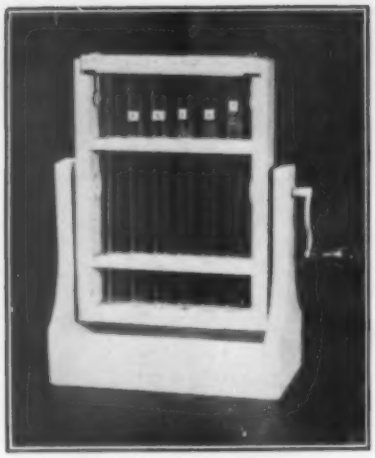
In the discussion of a paper on algae control in 1941, Dr. Thurlow P. Nelson[5] stated that Dr. Setchell, Botanist of the University of California, pointed out that there are definite ranges of temperature within which various flowering plants begin to grow and higher ranges at which they will flower. These critical temperatures were found to lie close to 41°, 50°, 59°, 68°, and 77° F. His studies showed that as the temperature passed the critical point certain species were suddenly stimulated to activity. Hydro-biologists working with algae and protozoa are finding similar critical temperatures. Owing to the more gradual temperature changes which occur in water, these ranges are more easily recognized and delimited than is the case with land plants.

Yearly Graph Shows Temperature Effect

Figure 1 is a chart showing total algae count by weekly average for a typical year. The temperature of the water throughout the year is shown at the top of the figure. Laboratory analysis is accomplished by the Sedgwick-Rafter Method. The curve marked "Total Algae Count" in this figure is the weekly average of the daily algae counts. The finer curve marked "Asterionella" is the weekly average of the count of Asterionella only. Likewise the dotted curve is the weekly average of the Aphanizomenon count only. The circles in the total algae curve indicate the points of treatment with copper sulphate. The circles on the temperature curve show the critical temperature points.

In reviewing Fig. No. 1 we note that there is a marked decrease in algae as the temperature drops below the first critical point of 41°. In fact, when the temperature of the water dropped to about 35°, to all practical purposes there were no algae present. Then in March a large increase in organisms was noted as the temperature passed the critical point of 41°. Then a drop in algae occurred as the temperature neared the second critical point of 50°, followed by a marked increase immediately after passing the 50° point around April 24th. High counts at this time were largely due to Asterionella, which could be tolerated, so no treatment was made.

Next there was a decrease until the water temperature began to approach the fourth critical point of 68°, followed by a marked increase in algae growth as the temperature neared the fifth point of 77° F. This increase was due principally to Aphanizomenon, which can cause trouble, and therefore was promptly squelched on June 8 by a copper sulfate treatment



TUBE inversion rack used in "D.M." Test
Honesdale, Pa. Water Co.

of 4 lb per mil gal.

The next marked increase of algae occurred as the temperature again approached the critical point of 77° at the end of August and the beginning of September. Again this increase was met with a copper sulfate treatment of 4.25 lb per mil gal. After September small increases in algae counts are noted around the critical points of 59°, 50°, and 41° with a sharp drop as the water cools below 41°.

Asterionella and Aphanizomenon

Examining the curve of Asterionella, it is observed that there is a major peak occurring after passing the critical point of 41°, a smaller peak after passing 50°. There is also a slight increase around June 26th, but note how the temperature curve flattens out at this point, caused evidently by cool nights. Asterionella passed out of the picture after the temperature passed the critical point of 68° but note how Asterionella again appears in November around the second critical temperautre point of 50°, with a marked increase at 41°, and then a drop as the temperature decreased to approximately 35°.

As the curve for Aphanizomenon shows, it appeared in June as the temperature passed the critical point of 59° with a marked increase after passing 68°. Note how the treatment which was made for Alphanizomenon knocked it out of the picture until August 14th and then note the rapid increase as the temperature approached the critical point of 77° to be squelched again by copper sulphate. Aphanizomenon then petered out as the water cooled, disappearing near the temperature point of 50°.

The author does not wish to create the impression that some types of algae do not grow in waters with temperature below 35° to 34° or at these temperatures. Organisms do grow in this cold water, and even underneath the ice. One in particular, Synura, can be obnoxiously troublesome, as its presence even in small numbers causes a very disagreeable taste and odor in the water.

Anabaena, Melosira, Mallomonas and Ulothrix

Figure 2 is an algae and temperature curve of the same year as Fig. 1. On this graph are indicated the starting and ending points of six algae which were prominent in the year's growth. No effort has been made to indicate separate peaks for each algae. Asterionella and Aphanizomenon have been discussed above and no further mention will be made of them. Some comment on four other algae is warranted.

Anabaena growth occurred after the water temperature passed the critical point of 68° and how it disappeared after the water again cooled below 68°. The second treatment with copper sulphate undoubtedly stopped it from dragging on.

Melosira started growing as the temperature reached the first critical point of 41° and ended growth at a temperature just above 59°.

Mallomonas began growth about 59° and disappeared as the temperature came back down to near 59°, immediately after the second reservoir treatment.

Ulothrix began growth near 70°, after the first treatment had removed Aphanizomenon, and remained until the temperature approached 41°.

It is well to remember that temperature changes can be rapid in shallow areas of a reservoir or lake. These temperature changes may stimulate algae into activity and cause the appearance of unexpected algae, though usually not in large numbers.

Therefore, with an eye on the water temperature, an operator can anticipate periods of rapid algae growth and the type of algae to expect. Also he will be able to tell when it is necessary to pay particular attention to microscopic examination.

When and How to Treat

It is the practice of some operators to treat a reservoir with copper sulphate in the spring without taking recourse to microscopic examination or making a study to determine the actual need of treatment. This type of control is wasteful unless there is actual need at that time as the copper will not remain in solution to destroy algae which may develop at a later period.

It is well to remember that water will contain food matter which will support the active growth of only a certain number of algae. Also, there is a constant battle for the survival of the fittest. Therefore, to kill off one type of algae before necessary may pave the way for fast growth of another and perhaps more objectional type of algae.

No set formula can be given as to when it is necessary to treat a water supply for algae control. Control requirements will vary for different supplies. An operator must constantly study his reservoir as a doctor studies his patient. From study and experience he must recognize the symptoms and prescribe the correct treatment. With constant study of the thermometer, the sky, and his microscope, he will be able to apply preventive treatment and not have a sick patient on his hands that will require a drastic cure.

The upper limit for each algae that can be tolerated in a particular supply must be determined. Then when the algae are increasing in numbers and reach the predetermined limit, and temperature is not changing favorably, it is time to treat. It is not essential or economical to treat a supply until these limits are reached.

Whenever any objectional algae are present in a supply and temperature is favorable to growth, daily microscopic examination is a must. With conditions right, the increase in algae count can be phenomenal.

After deciding when it is necessary to treat a supply, the next factor to consider is the amount of copper sulphate to use in treating.

Many Factors Govern Doses

In regard to the question of the amount of copper sulphate necessary to use in treating a supply, Dr. Hale[6] states, "Experience differs with waters of different composition, with temperature and with the amount of organism. It is a waste of chemical to apply an insufficient amount. If a smaller dosage fails, the entire larger dosage must be applied at one time."

Therefore, it is a waste of chemical to apply an insufficient amount, just as it is a waste to apply an excess amount.

According to the table based on data by Moore and Kellerman, Whipple and others[6] it will be noted that in many instances, more than one dosage rate of copper sulphate treatment is given for the same organism, as Aphanizomenon 1.0 to 4.2 lb per mil gal. If the supply should be treated for Aphanizomenon with 1.0 lb of copper sulphate crystals and 4.2 lb per mil gal should be needed, the

1.0 lb per mil gal treatment would be wasted as the 4.2 lb per mil gal must be applied at one time. Likewise if the 4.2 lb per mil gal were used and one pound would do the work, then 3.2 lb per mil gal would be wasted. Thus, this table must be tempered with experience as to the chemical characteristics of the water, the temperature, and the type of organism on hand.

With this method there is always uncertainty as to the outcome of the treatment, as variation in the type of organism and composition of the water will change the amount of copper sulphate necessary to remove the algae. Furthermore, when a treatment is effective, an operator does not know if he has added an excess amount of algicide and thereby wasted some of the chemical.

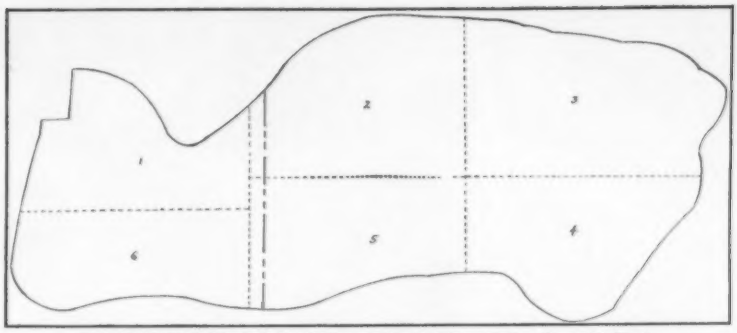
No Fixed Dose Possible

Copper sulphate is used in many plants in the form of continuous application. In a paper by Paul Weir[7] on this method of algae control, the following statement appears: "Microscopic examinations and threshold odor tests are important in attaining efficient application and control. *There is not one fixed dosage of copper sulphate suitable for any one condition,*" (italics by author) "but, generally speaking, an application of two to ten pounds per mil gal of water will be found effective in the elimination of the most objectional microscopic growths."

According to Whipple[3] the amount of copper sulphate to use in treating a supply depends on seven factors:

1. The kind of algae to be destroyed.
2. The amount of organic matter present.
3. The hardness of the water.
4. The carbonic acid content.
5. The temperature of the water.
6. The species of fish present.
7. The amount of water to be treated.

Much of the author's experience with algae control was obtained at the Canoe Brook Reservoir of the Commonwealth Water Co. located in Summit, N. J. While chemist for that company, the author devised a simple, practical laboatory test to determine the amount of copper sulphate necessary to use in treating a supply of water regardless of its temperature and composition, and, within certain limitations, regardless of the type and amount of organism present. This test, which became known as the "D.M. Test" after the author's late father, David Monie, who spent his entire working lifetime in the water works business, has been used successfully for the past fifteen years.



DIAGRAMMATIC sketch of Canoe Brook Reservoir—Summit, N. J.

Dotted lines show how reservoir is sectioned for purpose of sampling water and applying copper sulfate in proportion to water depth and algae concentrations.—During algae growing season each section is sampled daily for microscopic examination.

The D. M. Test

It was found that the addition of certain amounts of copper sulphate to water containing algae resulted in an increase in the alkalinity. It was further observed that the amount of copper sulphate needed to bring about this increase in alkalinity was the correct amount to use in treating. After much experimentation the following test was developed.

The equipment and chemicals necessary for the test are:

a. Six 50 ml. Nessler tubes.
b. A copper sulphate solution of a strength so that 2 ml added to a liter of water equals a copper sulphate treatment of 1.0 lb per mil gal.
c. Phenolphthalein indicator.
d. NaOH solution, 0.01136 N.

To make the copper sulphate solution mentioned in item b, dissolve 0.6 gram of the commercial copper sulphate used for treatment in 1 liter of distilled water. Dilute 100 ml of this solution to 1 liter with distilled water. Two ml of this final solution per liter of same equals 1.0 lb of $CuSO_4 .5H_2O$ per mil gal, or 0.1 ml per 50 ml of sample equals one pound of copper sulphate crystals per mil gal.

Test Procedure

Place 50 ml samples of the water to be treated in each of six 50 ml Nessler tubes A, B, C, D, E, and F. To tube A, add 0.1 ml of copper sulphate solution (b) to equal a treatment of 1.0 lb per mil gal.; to tube B, add 0.2 ml of solution (b); to tube C, add 0.3 ml of solution (b); to tube D, add 0.4 ml of solution (b); to tube E, add 0.5 ml. of solution (b). To tube E, add 0.5 ml of solution (b). To tube F, no copper sulphate is added. Tubes A, B, C, D, E now contain, respectively, copper sulphate dosages equal to 1.0, 2.0, 3.0, 4.0, and 5.0 lb per mil gal. These samples are then mixed by corking and inverting approximately thirty times simultaneously.

To the Nessler tube F (the blank sample) phenolphthalein indicator is added. If there is a negative amount of free carbon dioxide, enough indicator is added until there is a faint but distinct pink color. Then the same amount of phenolphthalein is added to each of the other samples. The samples are compared and the tube with the deepest color is the tube containing the sample to which has been added the correct amount of copper sulphate to use in treating.

Influence of Carbon Dioxide

If there is free carbon dioxide present (and there usually is), three drops of phenophthalein are added to each of the six samples in the Nessler tubes after they have been mixed with the various amounts of solution (b) as described above. Then 0.01136N sodium hydroxide is added to the Nessler tube F (the blank sample) until there is a faint but distinct pink color. The same amount of the sodium hydroxide is then added to the other five samples and the tubes are compared for color. The deepest color will be found to be in the tube containing the sample to which the most effective and economical amount of copper sulphate to use in treating has been added.

This test is practically the same as a free carbon dioxide titration. However, in the algae test it is simpler to have both the phenolphthalein and the sodium hydroxide in dropper bottles, as the equal amounts can be easily added to the sample tubes by counting the drops. The 0.01136 N sodium hydroxide concentration is used simply because finer control can be maintained on the color. In waters with considerable carbon dioxide, 0.02272 N can be used just as effectively.

It is important to note that the tube with the deepest color is always darker than the blank sample. Therefore, at the correct dosage of copper sul-

Courtesy Los Angeles Dept. of Water and Power

CONTINUOUS copper sulfate solution feed

phate the water is more alkaline than it was prior to the addition of the salt. This result is clearly shown in the test irrespective of the fact that phenolphthalein is not a sensitive indicator. The puzzling factor of the entire test is the fact that at a certain concentration of copper sulphate dosage the alkalinity is increased, and then with an excess of copper sulphate the alkalinity decreases to approximately the same point as it was in the blank sample. Therefore, the color in the tubes rises gradually with the dosage increase, and after reaching a maximum the overdosage causes a lessening color development.

When the "D. M." test was first developed, the author used a mixing machine with liter samples instead of the Nessler tubes. However, the reaction in the test is so fast that the results can be obtained quicker with equal accuracy using the Nessler tubes.

If more than one type of organism is present in sufficient numbers, it is possible to get two or more treating points by the "D. M." test. For example, Anabaena and Aphanizomenon were present at the same time in a reservoir. The "D. M." test showed two distinct treating points, two pounds per mg. and four pounds per mg. To use two pounds per mg. would have been a mistake as only the Anabaena would have been destroyed, which would leave conditions perfect for the rapid increase of the Aphanizomenon.

It is not to be assumed that this test reduces algae control to a routine matter and does away with the necessity of having a trained operator for this type of work. It is an additional tool for the trained man to work with.

Proper Method of Copper Application

Proper distribution of the copper salt through the reservoir water is important to successful algae control. Knowledge of the first two steps for algae control—when to treat, and how much copper sulphate to use in treating—would be of no value without proper application of the chemical. For example, if a 4.0 lb per mil gal treatment of copper sulphate is necessary, then the chemical must be applied so that the water in all parts of the reservoir has received approximately the same dosage rate. The deeper parts of the reservoir must receive in proportion more copper sulphate than the shallow parts. If this is not done, some portions of the water will be undertreated and the algae not killed in these parts remain to re-seed the reservoir.

Here again, a detailed study of conditions of each reservoir must be made and the method of application decided upon after careful deliberation. In the majority of lakes the best method of application is by dissolving the copper sulphate from burlap bags or perforated boxes attached to a boat. However, in some lakes and for certain types of algae some other method of application such as spraying either a solution of copper sulphate or broadcasting the pulverizing dry salt may be more practical.

Knowledge of Reservoir Topography Important

In order to obtain proper uniform distribution of the chemical, a knowledge of the reservoir bottom topography is an important consideration. If a contour map of the reservoir bottom, is not available, one should be made. The points for preparing such a map are easily obtained by sounding from a boat, or from the ice in northern regions.

When the reservoir bottom topography is known, it is a simple matter to section the reservoir into areas of approximately uniform depth. With this knowledge it is possible to apportion the copper sulphate in treating so that equitable application can be planned and made. In deep reservoirs usually only the top twenty to thirty feet depending upon stratification need be considered in treating.

The most common method of treating is by a boat propelled by an outboard motor. The chemical is placed in two burlap bags, one on each side of the boat, suspended from frames so that additional copper sulphate can be added to the bags to keep the amount of chemical exposed to the water uniform. The strength of the treatment is regulated by the level of copper sulphate crystals carried in the bags.

The conventional strip method is used in treating. The width of strip may vary between 40 to 100 ft. The narrower the strip that will allow full treatment in a working day the better the results. The same width of strip should be adhered to regardless of the amount of chemical per treatment,

the amount going into solution depending upon the amount exposed to the water.

In a case where a reservoir is so large that strips over 100 ft are necessary, more than one boat should be used in treating. Other methods of "coppering" a reservoir have been described by Darby[8].

Continuous Feed

Where local conditions permit, continuous feed of copper sulphate may prove the best method of application. Especially where water passes through a chain of reservoirs.

With labor cost increasing it may be more economical to use continuous feed although it may result in chemical waste.

Conclusion And Comment

Once started on the study of algae, the result will not only be a far superior water but also a fascinating hobby.

Results of proper application of the three fundamentals of algae control will be most gratifying. Proper treatment actually destroys the organism and does not allow, as in the case of improper treatment, half dead organisms to remain and re-seed the reservoir when conditions for growth again become favorable.

With proper treatment, results are evident within a 24-hour period after treatment, never more than 48 hours. Where results are not shown for from 3 to 7 days or more after treatment, the apparent result is probably due to other changes such as temperature as much as from the sulphate treatment.

The following library is very helpful in a study of algae:

Courtesy Los Angeles Dept. of Water & Power

MOTORBOAT method of coppering

Belt-conveyor sketched below is set to feed copper sulphate at predetermined rate in propeller stream

"Standard Methods for the Examination of Water, Sewage, and Industrial Wastes", Tenth Edition, APHA, AWWA, FSIWA.

"The Microscopy of Drinking Water" by George C. Whipple, John Wiley, New York.

"The Use of Copper Sulphate in Control of Microscopic Organisms", Phelps-Dodge Refining Co., New York

References:

(1) Fitch, C. P. et al "Water as a Cause of Poisoning in Animals." *Cornell Vet.* 24:1; 30 (1934)

(2) "Standard Methods for the Examination of Water, Sewage, and Industrial Wastes," 10th Ed. APHA, AWWA, FSIWA.

(3) "The Microscopy of Drinking Water" by George C. Whipple, John Wiley, New York.

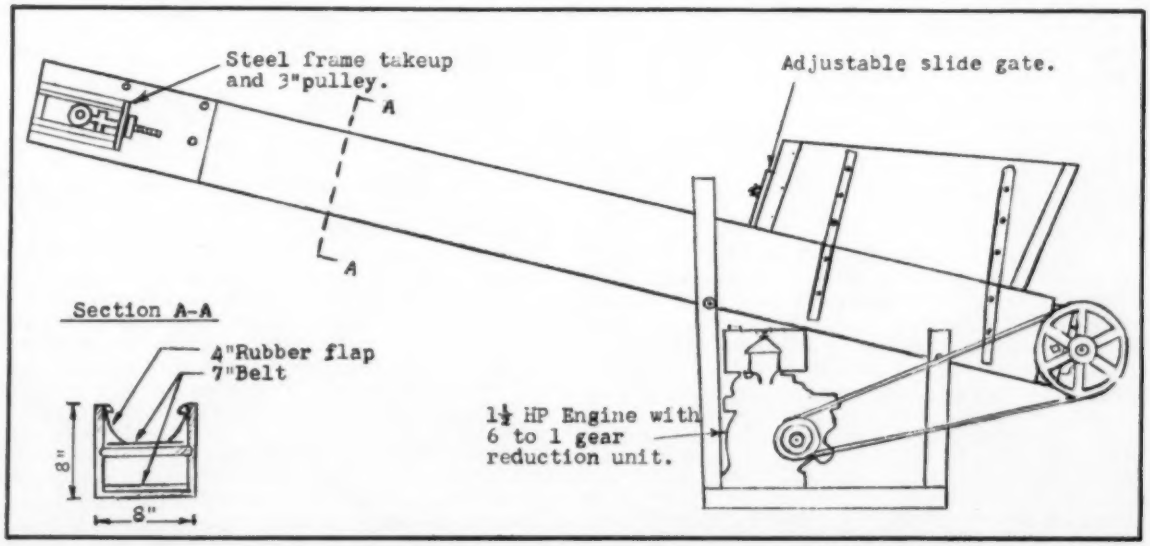
(4) Palmer and Tarzwell, *Public Works*, June, 1955, "Algae of Importance in Water Supplies."

(5) Monie and Nelson, "Algae Control," *Jour. AWWA*, April, 1941.

(6) Hale, Frank E., "The Use of Copper Sulphate in Control of Microscopic Organisms," Phelps-Dodge Refining Co., New York.

(7) Weir, Paul, "Copper Sulphate in the Water Purification Plant," Water Works & Sewerage, May, 1939.

(8) Derby and Townsend, "Reservoir Treatment by Improved Methods" *Water & Sewage Works*, June, 1953.



Courtesy Los Angeles Dept. of Water & Power

SPECIFICATION sketch for belt-conveyor type copper sulfate feeder (not to scale).

Bettman Archive

Notes on Water Works Law

by JOHN H. MURDOCH, JR.

Mr. Murdoch is Vice-President of American Water Works Co., Inc., and Chief Counsel of American Water Works Service Co., Inc., Philadelphia, Pa. He has prepared exclusively for *Water & Sewage Works* this series of articles discussing water works law as it applies to source of supply, water quality, and water distribution.

Ninth Installment

Legal Aspects of Water Fluoridation—Part I*

THE LEGAL ASPECTS of water fluoridation considered here will be limited to the legal and constitutional questions involved in the question of whether the program may be carried forward. Questions concerning legal responsibility for damages which might be suffered by a user of water to which the public water supply agency has added fluorides are covered by earlier installments of these "Notes" under the subject of "LIABILITY FOR FURNISHING WATER DANGEROUS TO HEALTH", where the general principles are set forth. Of course, there will be no discussion here of the wisdom or lack of wisdom of artificial fluoridation of public water supplies although some of the quotations from court opinions touch on that matter. Legal questions rather than policy matters are the subject of consideration.

Proponents of fluoridation take the position that it may be ordered or authorized by direct or indirect legislative action in the exercise of the police power of the state or municipality. On the other hand, opponents contend that the legislative action involved is not a valid exercise of the police power and is, therefore, unlawful or unconstitutional. To appreciate the arguments advanced it is necessary to have an understanding of the "*police power*" at least as it relates to public health and an understanding of the limitations on that power. Appreciation of some of the arguments used by opponents of fluoridation requires the quotation of brief excerpts from the 1st and 14th Amendments to the Constitution of the United States.

Nature of Police Power—
With Special Reference to Public Health and Limitations on its Use

In the case of *JACOBSON* v. *MASSACHUSETTS*, 197 U.S. 11; 25 S. Ct. 358; 49 L. Ed. 643; Mr. Justice Harlan in the opinion was discussing a statute regarding vaccination. The following is quoted. "The authority of the State to enact this statute is to be referred to what is commonly called the police power—a power which the State did not surrender when becoming a member of the Union under the Constitution. Although this court has refrained from any attempt to define the limits of that power, yet it has distinctly recognized the authority of a State to enact quarantine laws and 'health laws of every description'; * * *. According to settled principles, the police power of a State must be held to embrace, at least, such reasonable regulations established directly by legislative enactment as will protect the public health and the public safety. * * * It is equally true that the State may invest local bodies called into existence for purposes of local administration with authority in some appropriate way to safeguard the public health and the public safety. The mode or manner in which those results are to be accomplished is within the discretion of the State, subject, of course, so far as Federal power is concerned, only to

*Because of the justifiable length of this ninth installment it becomes necessary to publish Mr. Murdock's contribution in two parts. Part 2 will appear in our next (October) issue.—The Editor.

the condition that no rule prescribed by a State, nor any regulation adopted by a local governmental agency acting under the sanction of state legislation, shall contravene the Constitution of the United States or infringe any right granted or secured by that instrument * * *."

In the case of *CHAPMAN v. CITY of SHREVEPORT*, 225 Louisiana Reports 859; 74 Southern 2d 142; the opinion of the Supreme Court of Louisiana contains a short statement of the general principles concerning the police power of a municipality relative to public health and also of the limitations on the exercise of the power. The court said: "* * a municipal authority may take any action it may determine to be necessary and expedient under its police power in the domain of public health, provided the purpose and object of such action bears a *reasonable* relation to the public health and provided the means employed is not arbitrary, unreasonable, oppressive, or violative of the constitutional guarantees of the citizens. * * Moreover, it is well settled that courts will not interfere with the legislative authority in the exercise of its police power unless it is plain and palpable that such action has no real or substantial relation to the public health or safety or general welfare."

Since the quoted opinions are typical of many that could be cited, it is plain that a state may adopt such legislation as it deems wise to promote or safeguard the public health and that it may delegate such legislative powers to local governing bodies, such as municipal councils or to departments of health. It is also clearly established that a public health enactment will be a valid exercise of the police power unless: (1) its purpose and object bear no reasonable relation to public health; (2) the means employed are arbitrary, unreasonable, or oppressive; or (3) the means, rule or regulation adopted contravene constitutional rights of the citizens. Those who have opposed fluoridation in the reported cases in the courts have taken the position that the legislation under which the program was to be carried out was invalid because it fell in one or more of the three limitation classes.

It has been claimed that fluoridation of public water supplies contravenes the rights of citizens under the 1st and 14th Amendments to the Constitution of the United States—See item (3) above. The relevant portions of those amendments are here quoted.

> "*Article I.* Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; * * *
>
> "*Article XIV.* Sec. 1. *** No state shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States; nor shall any State deprive any person of life, liberty, or property, without due process of law; nor deny to any person within its jurisdiction the equal protection of the laws."

Summary Statement of Various Positions Advanced by Opponents of Fluoridation of Public Water Supplies

To facilitate understanding of the cases, to be cited herein, it may be stated that the persons who pressed the proceedings took the general position in all the cases that the fluoridation legislation under which the program was to be carried forward was invalid under one or more of the recognized limitations on that power listed above. In some of the cases there were also questions concerning the legislative power under the state constitution and of local power under municipal charters or grants of regulatory authority. These questions involve purely state or local law and are ignored in these "Notes." Only one case can be cited involving a privately owned water company. In this, the opponents raised the point that the company had no charter power to fluoridate and that its compliance with the police power legislation was, therefore, *ultra vires*. The court held that under the evidence only the attorney general of the state could take action and expressed no opinion on whether the company was acting beyond its powers. At the end of this two-part installment certain specific questions which have been submitted will be answered. One of these questions concerns distinctions, if any, between public and private water systems with respect to fluoridation. The question of charter powers is mentioned briefly in answer to the first question.

Those fighting fluoridation through court action advanced one or more of the following points:

(1) The legislation bore no reasonable relation to public health because no contagious or communicable disease was involved, there was no pressure of great public danger.

(2) The means employed are arbitrary, unreasonable and oppressive because all are required to buy water containing fluorides although only a very small minority will receive any benefit and there may be ill effects.

(3) The legislation contravenes the rights of citizens under the Constitution of the United States: (a) it requires medication contrary to certain religious beliefs and is therefore violative of the 1st Amendment; (b) it contravenes the privileges and liberties of citizens guaranteed under the 14th Amendment because it takes away the freedom to treat disease as the citizen may wish; and, the right to bring up children as the citizen may wish.

(4) The legislation puts the state unlawfully into the practice of medicine, dentistry or pharmacy.

(5) The legislation provides for the adulteration of water.

No case has been discovered where any one of these objections was found to be sound.

Cases Cited

C. LEON deARYAN, Appellant, v. JOHN D. BUTLER, Mayor of San Diego, et. al., Respondents. 119 Cal. Appellate Reports, 2d, 674; 260 Pac. 2d, 98. Decided by California District Court of Appeal, Fourth Appellate District, August 13, 1953. Petition for rehearing denied August 31, 1953 and Appellant's petition for hearing by Supreme Court of California denied October 8, 1953. Certiorari denied, U.S. Supreme Court, 347 U.S. 1012 (1954); 74 S.C. 863.

The plaintiff (Appellant), filed an action to enjoin the city officials from adding a fluoride compound, in an amount sufficient to maintain one part of fluoride per one million parts of water furnished to consumers of water in the city of San Diego. The city council had adopted a resolution authorizing and directing the City Manager to apply to the State Board of Health for an amendment of the water permit of the City to allow the City to add fluorides to its water furnished to its consumers. The resolution recited in its preamble that the dental and medical societies and the city Public Health Commission had recommended to the Council "that it will be directly in the interests of the health of the people of the City of San Diego to furnish to water consumers in said City water which has been treated by adding to its contents fluorides, and that this Council should endorse the principle of artificial fluoridation, with respect to the supplying of water to the people of the City of San Diego".

The next paragraph of the preambles reads as follows: "Whereas, this Council is of the opinion that such recommendation should be followed, and that it will be in the interests of the public health and the dental health of the residents of San Diego and the water consumers of said City to treat the water served to consumers within said City by adding to it an approved fluoride compound * * *."

The resolution was adopted after a public hearing at which both preponents and opponents presented testimony concerning the proposal.

Before the lower court the plaintiff presented testimony and evidence in the form of exhibits and reports. These reports were part of the matters submitted to the Council at its hearing before adoption of the resolution. A nonsuit was granted and the plaintiff took an appeal.

The appellate court held that in adopting the fluoridation resolution the city council had not exceeded the authority granted to it by its charter and under the state "Health and Safety Code". It stated:

"It therefore is apparent that the legislature has delegated to the State Board of Health the duty and powers necessary to control and regulate the purity, potability and wholesomeness of public waters in this state.

"The Legislature is possessed of the entire police power of the state, except as its power is limited by the provisions of the Constitution and other laws applicable thereto. Such police power is an indispensable prerogative of sovereignty and may not be legally limited even though at times its operation may seem harsh, so long as it is not unreasonable and arbitrarily invoked and applied."

"* * * unlawful for any person to furnish or supply to a user water used or intended to be used for human consumption or for domestic purposes which is impure, unwholesome, unpotable, polluted, or dangerous to health. * * * These are the only statutory regulations as to the quality of water to be furnished to consumers in this state, and the State Board of Public Health has made a finding that the water to be furnished under the fluoridation program does comply with these statutory standards. It therefore appears that the city council did not exceed the authority granted it under the Health and Safety Code. It is within the authority of a city to adopt regulations designed to promote the health and welfare of the people. * * *

"We therefore conclude that the addition of fluoride to the water supply, as directed by resolution of the city council, was a valid exercise of the police power of the City of San Diego, so long as it was not unreasonable or an abuse of discretion so to do. * * * The determination by the legislative body that a particular regulation is necessary for the protection or preservation of health is conclusive on the courts except only to the limitation that it must be a reasonable determination, not an abuse of discretion, and must not infringe rights secured by the Constitution.

"The only possible question remaining is whether or not the fluoridation of the water supply, under the evidence produced, was a plain, palpable invasion of the rights secured by fundamental law."

The plaintiff in this connection raised questions under the first, tenth and fourteenth amendments to the Constitution of the United States. He also raised the question of freedom of religion under the laws of California and under the Constitution. The court held:

"It does not clearly appear from the evidence produced that the ordinance is a plain, palpable invasion of the rights secured to petitioner by the fundamental law, nor does it appear that it violates any policy or laws of the State of California or that by reason of the facts established the ordinance is in the respects indicated unconstitutional. The matter was one within the sound discretion of the city council."

The order of the lower court, granting a nonsuit to the City, was affirmed.

CHAPMAN v. CITY OF SHREVEPORT, 225 Louisiana Reports 859; 74 Southern, 2d 142. Decided May 31, 1954; Rehearing denied July 2, 1954. Appeal dismissed by United States Supreme Court, 1954—75 S. Ct. 216; 348 U.S. 892.

This was a suit to restrain the proposed fluoridation of a city's public water supply. The lower court granted a preliminary injunction and the City appealed. The Supreme Court of Louisiana held that the resolution effectuating the plan for fluoridation bore a reasonable relationship to the general welfare and health of the community and was a valid exercise of the police power. The judgment of the lower court granting the preliminary injunction was reversed. The following is quoted from the Opinion of the Supreme Court: * * * *

"As we appreciate and understand the trial judge's written opinion, he granted a preliminary injunction in the instant case because in his opinion the charter of the City of Shreveport delegated no authority, express or implied, to the city to fluoridate its water supply, and the city did not have this power or right under its police power in the domain of public health. In the course of his reasons for judgment he recognized the well settled principle of law that a municipal authority may take any action it may determine to be necessary and expedient under its police power in the domain of public health, provided the purpose and object of such action bears a reasonable relation to the public health and provided the means employed is not arbitrary, unreasonable, oppressive, or violative of the constitutional guarantees of the citizens. He concluded, however, that under the facts of the instant case the fluoridation of the city water supply bears no reasonable relation to the public health or that it is not a matter of public health but is strictly within the realm of private dental health and hygiene, in which each person should be free to choose his course for himself and those for whom he is responsible in the family relationship.

"For the primary *purpose of reducing tooth decay in children 12 years of age and under*, the City of Shreveport proposes to add to the water furnished by it for the use and consumption of the citizens sodium fluoride in the proportion of one part per million. In furtherance of this purpose the resolution authorizing the calling for bids for the necessary equipment for fluoridation was adopted by the city council at the request of the Council of Dental Health of the Louisiana State Dental Society, the Council of Dental Health of the Fourth District Dental Association, the Shreveport Medical Society, and the City Board of Health of Shreveport, all of which advocated and approved the fluoridation of the city's water supply. * * *

"* * * if fluoridation of the water supply bears any reasonable relation to the public health, it can be undertaken by the city under the express provisions of this section of its charter. Moreover, it is well settled that courts will not interfere with the legislative authority in the exercise of its police power unless it is plain and palpable that such action has no real substantive relation to the public health or safety or general welfare. * * * * There also exists a presumption that an ordinance adopted under the police power of the state is valid, and the burden of proving the contrary is on him who asserts the invalidity or nullity. * * * *

"Although the immediate purpose of the proposed fluoridation is to retard and decrease the disease of dental caries in young children, the protection thus given will continue well into adult life. Not only will the proposed fluoridation retard and reduce this disease in the generation of children presently in Shreveport, but its effect will continue into their adult life, and consequently the proposed measure will ultimately be benficial to all the residents of the city.

"The health of the children of a community is of vital interest and of great importance to all the inhabitants of the community. Their health and physical well-being is of great concern to all the people, any any legislation to retard or reduce disease in their midst cannot and should not be opposed on the ground that it has no reasonable relation to the general health and welfare. Children of today are adult citizens of tomorrow, upon whose shoulders will fall the responsibilities and duties of maintaining our government and society. Any legislation, therefore, which will better equip them, by retarding or reducing the prevalence of disease, is of great importance and beneficial to all citizens. *In our opinion the legislation bear a reasonable relation to public health.*

"The appellees insist, and the district judge concluded, that fluoridation of the water to prevent tooth decay is not a matter of public health, but a matter of private health and hygiene. The evidence in this record refutes overwhelmingly this conclusion. Dental caries is one of the most serious health problems in the City of Shreveport, and in the nation as well. The fact that it is not a communicable disease and one that can cause an epidemic does not detract from its seriousness as affecting the health and well-being of the community. The plan for fluoridation, therefore, bears a reasonable relation to the general welfare and the general health of the community, and is a valid exercise of the power conferred by Section 2.01 of the charter if it is not arbitrary or unreasonable.

"The appellees contend that fluoridation of the water supply is arbitrary and unreasonable because it *may* cause serious ill effects to the adult, aged, and ill; that it is arbitrary to fluoridate the water until clinical tests have proved that these serious effects will not result. The appellees have failed completely to prove that fluoridation would be harmful to the aged and ill.

"There is expert opinion of respectable medical authority that fluorides added to water will have no more harmful effect than fluorides naturally appearing in water, and that in those places where fluorides naturally appear no ill effects have been experienced by the aged or ill of the population. In those places where tests have been conducted no ill effects have been shown. It cannot be said then, that the City of Shreveport is acting arbitrarily from this point of view.

"Appellees contend that it is arbitrary and unreasonable to compel a person to submit to the taking of preventive medicine except for the purpose of controlling the spread of contagious or infectious diseases. Their argument is not entirely appropriate to the instant case. In the first place there is no direct compulsion on anyone to drink the water. The compulsion at most is an indirect one, but it cannot be questioned, of course, that the fluoridation is undertaken with the view that the citizens or a large majority of them will receive its benefits by drinking the public water. The witnesses from the dental profession considered that the addition of fluoride to the water was not medicating it in the generally accepted sense, but was adding to it one of the mineral properties found naturally in water in some sections of the country.

"Appellees next argue that it is unreasonable to fluoridate the water when it will reduce the incidence of disease only among a limited class. A health measure is not necessarily arbitrary because it affects primarily one class. It may, even so, be in the interest of the public generally. Ultimately, of course, the fluoridation will benefit the whole population because the retarding of decay extends into adult life of the child who has had the benefit of water containing fluorides. It has long been recognized that a police measure is not objectionable because it does not extend to all classes. * * * * *

"There is no merit in appellees' argument that, if the city charter grants to the city council of Shreveport authority to fluoridate its water supply, such action to that extent is a violation of the Fourteenth Amendment of the United States Constitution. The Fourteenth Amendment does not deprive a state or its subdivisions of the right to preserve order or to protect the health of the people under its police power, and in the exercise of its power the legislative branch may interfere with and impair the individual liberty of the citizens in a manner and to an extent reasonably necessary for the public interest, and the courts will not interfere except where the measures invade fundamental rights or are arbitrary, oppressive, or unreasonable. This is not a proper case for judicial interference. * * * *"

DOWELL, et al. v. CITY OF TULSA, et al., 273 Pacific 859, Decided by the Supreme Court of Oklahoma, June 15, 1954. Rehearing denied July 13, 1954; Certiorari denied U. S. Supreme Court 1955, 75 S. Ct. 292; 99 L.E. 207.

Action by taxpayers to enjoin enforcement of and compliance with city ordinance authorizing the fluoridation of city water supply. The District Court of Tulsa County entered judgment of the city denying the injunction and the plaintiffs appealed. The Supreme Court of Oklahoma held that enactment of the city ordinance authorizing the fluoridation of city water supply constitutes a valid exercise of the police power delegated to municipalities by the state Constitution and statutes to promote and protect the public health and that such ordinance does not violate any statutory or constitutional provision.

From the Court's Opinion :

"* * * * Plaintiffs in error commenced the present action, as plaintiffs, to enjoin defendants in error, as defendants, from enforcing and/or complying with * * * *, authorizing fluoridation of said city's water supply by its Water Department and Commissioner of Waterworks and Sewerage. The purpose of such fluoridation, as indicated in the ordinance, was 'to aid in the control of dental caries' (tooth decay), and by reason of the emergency therein declared to exist for "preservation of the public peace, health and safety', it was provided by Section 4 thereof that the ordinance would become effective upon its passage, approval and publication. * * * *

"Plaintiffs are individual taxpayers of the city. Their effort to enjoin the enforcement of the Ordinance was based upon the alleged ground that it is invalid. The only alleged reasons for such invalidity which they apparently urged are that (1) the ordinance constitutes an 'unwarranted exercise of police power' in violation of the Fourteenth Amendment of the U. S. Constitution; (2) that it is an exercise of power beyond that delegated to the city by the State Legislature; (3) it violates the U. S. Constitution's First Amendment concerning freedom of religion; and (4) it violates Title 63 O.S. 1951 Sec. 196 forbidding the manufacture and sale of 'food' to which 'fluorine compounds' have been added as the

term 'food' is defined in Section 183 to include 'articles of food, meat, drink * * * * beverage' * * * *.

"With apparent reference to (1) and (3) above, plaintiffs contend under the first two proportions formulated in their briefs that our State Legislature has never established a policy of attempting to regulate or control any disease except those that are 'contagious, infectious or dangerous;' and that it could not constitutionally do so. In denying the first part of this contention, defendants point to various statutes enacted by the Oklahoma Legislature, particularly sections appearing under Title 63 O.S. 1951, which they say plainly show that its policy in matters of public health and welfare has never been confined to seeking control, regulation and prevention of contagious, infectious, or dangerous diseases. Among these are provisions for safeguards pertaining to bedding and the germicidal treatment of secondhand materials, * * * *; provisions requiring the injection of 'nitrate of silver or other proven antiseptic' into the eyes of newborn infants, for their protection against 'Inflammation of the eyes * * *' (opthalma neonatorum), * * * *; those pertaining to the regulation of milk production and marketing, * * * *; and of hotels, etc., * * *; to * * * * section * * * specifying the vitamin and mineral requirement for flour; * * * * and creating in the State Health Department a division to be known as the 'Division of Preventive Dentistry'. * * * * In fact, it was apparently in conformity with the provisions of the latter section that said State Department made its study of the fluoridation of public water supplies for controlling dental caries and promulgated certain rules and recommendations, or a policy to govern it in assisting municipalities considering such projects. * * * *

"In view of the broad terms in which our Legislature has spoken on the subject, we cannot believe that it has intended to restrict its enactment of measures designed to promote the public health and welfare to those designed to prevent the spread of infectious, contagious or dangerous diseases. We think the mere reading of the statutes herein cited and others enacted by our Legislature is sufficient to show that it has not so restricted its policy, and that it has chosen to make many minimum requirements with reference to food, lodging and a myriad of subjects connected with the public health and/or welfare that have no direct connection with or relation to infectious, contagious or dangerous diseases.

"The next question then is: Recognizing that such a thing is not against public policy as declared by our Legislature, can the police power delegated to a city by the Legislature be exercised to the extent of what inpractical analysis amounts to a compulsory measure requiring people of the city to use or pay for water that is fluoridated in order to control a physical characteristic or weakness which is not an infectious, contagious or dangerous disease? Plaintiffs say that it cannot—that under the guarantees of freedom contained in the 1st and 14th Amendments to the U. S. Constitution the citizens of Tulsa have a right to be furnished city water not 'medicated' or treated with fluorides. We do not agree.

"* * * * In suggesting negative answers to the above-quoted questions when propounded about Ordinance 6565, it seems to be plaintiffs' position that (1) since it is not contended that Tulsa's water is not pure, or that unless treated with fluorides it will tend to spread contagious disease or that an epidemic of an infectious or dangerous disease is threatened or imminent unless said water is so treated, the exercise of the police power to the extent of interfering with Tulsa citizens' freedom to purchase and use its water without such treatment cannot be justified; that (2) since the only direct evidence on the matter went no further than showing that drinking fluoridated water reduces caries in the lower-age group of minor persons, such treatment could not be justified as a measure to improve the health or welfare of the public generally; (3) that the evidence tended to show that the same object could be attained by leaving to individuals the treatment of their own drinking water with fluorides on an individual and voluntary basis, as could be attained by requiring the wholesale treatment of the City's entire water supply and therefore that the latter is not 'reasonably necessary' to attain that end, thus belying the Ordinance's announced representation or misrepresentation that it is necessary to preservation of the public health and safety. We do not find any of these arguments tenable for the reasons hereinafter set forth. While most of the reported cases that have arisen in the past involved the so-called 'purity' or 'purification' of municipal water supplies and the regulations upheld with reference thereto were designed to prevent contamination or pollution with consequent epidemics or spread of disease, notice Annotations, 6 A.L.R. 228, and 8 A.L.R. 673; 23 A.L.R. 228; 72 A.L.R. 673, we think the weight of well-reasoned modern precedent sustains the right of municipalities to adopt such reasonable and undiscriminating measures to improve their water supplies as are necessary to protect and improve the public health, even though no epidemic is imminent and no contagious disease or virus is directly involved. See Blue v. Beach, 155 Ind. 121, 56 N.E. 89, 50 L.R.A. 64; and the Annotations thereto, at 80 Am. St. Rep. 212; 25 Am. Jur., 'Health', Secs. 21 and 25, inclusive; 56 Am. Jur. 'Water Works', Sec. 76. Where such necessity is established, the Courts, especially in recent years, have adopted a liberal view of the health measures promulgated and sought to be enforced. * * * * As knowledge in both the medical and dental fields has increased, the subject of health in both of these spheres has become more important, and modern experience shows that private convenience and individual freedom of action are required to yield to the public good in instances where formerly there was observed no necessity for legislative interference. * * * * * No principle is better established in our system of jurisprudence than the one that 'Liberty implies the absence of arbitrary restraint, not immunity from reasonable regulations * * * imposed in the interests of the community'. * * * * Plaintiffs concede, as they must, that municipalities may chlorinate their

water supply, Commonwealth v. Town of Hudson, 315 Mass. 335, 52 N.E. 2d 566; McQuillin Municipal Corporation (3d Ed.), Vol. 7, Sec. 24.265 and though they contend, under one proposition, that a city's treatment of its water supply with fluorides is the unlicensed practice of medicine, dentistry and pharmacy under our Statutes, they here argue that such treatment must be distinguished from treatment with chlorides, because the latter will kill germs, purify water and accordingly aid in the prevention and spread of disease, whereas fluorides will not. We think that if the putting of chlorides in public water supplies will in fact promote the public health, the distinction sought to be drawn by plaintiffs is immaterial. To us it seems ridiculous and of no consequence in considering the public health phase of the case that the substance to be added to the water may be classed as a mineral rather than a drug, antiseptic or germ killer; just as it is of little, if any, consequence whether fluoridation accomplishes its beneficial result to the public health by killing germs in the water, or by hardening the teeth or building up immunity in them to the bacteria that causes caries or tooth decay. If the latter, there can be no distinction on principle between it and compulsory vaccination or inoculation, which, for many years, has been well-established as a valid exercise of police power. * * * * While the evidence in the present case did not purport to establish fluoridation as a remedy or prevention for any specific contagious disease, it did show, without contradiction, that it will materially reduce the incidence of caries in youth. The relation of dental hygiene to the health of the body generally is now so well recognized as to warrant judicial notice. Accordingly, we hold that in establishing the fluoridation prescribed by Ordinance 6565, as effective to reduce dental caries, the evidence also sufficiently established it as a health measure to be a proper subject for exercise of the police power possessed by the City of Tulsa.

'We now come to plaintiffs' argument that fluoridation of Tulsa's water supply cannot be justified as a *public* health measure because the evidence went no further than establishing it as an aid to the prevention of caries in persons under sixteen years of age, and tended to show that consumption of such water is of no benefit to older persons. The evidence did not reveal what proportion of Tulsa's population is under sixteen years of age, but under our view this was not necessary. When it is borne in mind that the children and youth of today are the adult citizens of tomorrow, and that this one segment of the population unquestionably benefited by the drinking of fluoridated water now, will in a few years comprise all or a very large percentage of Tulsa's population; and it is further realized that reducing the incidence of dental caries in children will also benefit their parents, the fallacy of plaintiffs' argument is manifest. * * *

"Plaintiffs do not elaborate on their contention that Ordinance 6565 is in violation of the 'free exercise' of religion, which, in the First Amendment of the United States Constitution, Congress is forbidden to prohibit, but we assume this is based on the hypothesis that the fluoridation prescribed in the Ordinance is a form of 'medication' or 'medical treatment' forbidden by the tenets of one or more well-known churches or religious sects. This argument is closely allied to one phase of the plaintiffs' 'Proposition 4' to the effect that fluoridation is treatment of a diesase and therefore that the Ordinance constitutes the unlicensed practice of medicine as defined and forbidden in Title 59 O.S. 1951 Sections of 495b and 497. To what was said concerning a similar argument in deAryan v. Butler, supra, which we hereby approve and adopt, we wish to add our opinion that in the contemplated water fluoridation, the City of Tulsa is no more practicing medicine or dentistry or manufacturing, preparing, compounding or selling a drug, than a mother would be who furnishes her children a well-balanced diet, including foods containing vitamin D and calcium to harden bones and prevent rickets, or the findings and supported the conclusion that a drinking-lean meat and milk to prevent pellagra. No one would contend that this is practicing medicine or administering drugs. * * * *"

FRONCEK, et al. v. CITY OF MILWAUKEE, 269 Wisconsin 276; 69 N.W. 2d, 242; Decided by the Supreme Court of Wisconsin March 8, 1955.

Residents, taxpayers and water users in the City brought action against the city and city officials to restrain them from expending any money in carrying out resolution of city's common council providing for fluoridation of city's water supply. The Circuit Court entered summary judgment in favor of city and city officials; and, plaintiffs appealed. The Supreme Court of Wisconsin held that the resolution was a reasonable exercise of the police power and was valid. * * * *

Quoted: "Plaintiffs seek a restraining order against defendants to prevent them from expending any money, directly or indirectly, in carrying out a resolution adopted October 24, 1950, by the common council of the city of Milwaukee reading as follows:

" 'Resolution relative to fluoridation of the city's water supply: Resolved, by the common council of the city of Milwaukee, that the water department be and hereby is authorized and directed to provide the means to proceed as early as possible in the year 1951 with the fluoridation of the city's water supply; and be it: Further resolved, that the board of estimates be and hereby is authorized and directed to appropriate in the 1951 proposed budget a sufficient sum of money to carry out the aforesaid purpose.'

"Both sides moved for summary judgment in the circuit court. The plaintiffs' motion was denied. The defendants' motion to dismiss the complaint was granted, 'the court having concluded, based upon the substantially undisputed material facts, as follows:

" '1. That it has jurisdiction to determine the primary issues which deal with acts of the city in its governmental capacity and not in the proprietary capacity. * * * *

" '5. That the fluoridation as prescribed does not constitute an adulteration of food.

" '6. That the fluoridation is not the practice of medicine, dentistry, or pharmacy, by the city.

" '7. That the legislation is a public health measure, bearing a real, substantial, and reasonable relation to the health of the city.

" '8. That the rights claimed by each of the plaintiffs, as follows: (1) the right to treat his health as he deems best; (2) the right of parents to bring up and care for their children as they deem best; (3) the right to be free from medical experimentation; (4) the right of freedom of religion; and (5) the right to have the same type and quality of water pass through their plumbing systems as passed through it when constructed; all are such as must give way to a public health measure determined by the legislative body to be necessary and adopted for the common good and welfare of the public, or a substantial segment thereof, under the police power of the

city; and such power has not been exercised in an arbitrary and oppressive manner.

" '9. That the court may not determine whether such legislation is or is not the best way to promote and protect the public health, but can only determine whether the action of the legislative body was and is within the bounds of reason, which it does determine.

" '10. That the validity of the legislation does not depend upon the existence of an emergency, overriding public necessity, epidemic, contagious or infectious disease; but is valid as a public health measure, the legislative body by its enactment having determined it to be necessary, and it bears a real, reasonable, and substantial relation to its objects. * * * *

" 'Now, therefore, it is ordered, adjudged, and decreed; * * * " '2. That defendants' motion for summary judgment dismissing the complaint of the plaintiffs be, and the same is hereby granted on the merits and the defendants do have and recover of the plaintiffs $10 motion costs.'

"* * * *

"As in cases to which reference will be made, the city of Milwaukee, as one of its proprietary functions, operates a municipal water department, and by reason of the general control and convenience of use of the water supply it has a practical monopoly in furnishing drinking water to thousands of the residents of the city. They are served through a system of underground mains and pipes maintained by the city, and thus the city enjoys a practical monopoly of the service of water therein. The city, through the passage of various resolutions and actions taken by its officials, has determined to treat all of the water supply of the so-called city water with fluorides. It is to this procedure that the appellants object. The resolution and enactment under consideration in the fluoridation of the water supply have been put into effect. The policy is fixed, and the respondents are treating all of the water supply of so-called city water with fluorides.

"The appellants earnestly, and with marked degree of thoroughness in the presentation of their views, insist that the substance of the controversy involves the welfare of a million or more people. They place great importance on their claim that there is involved 'the direction in which our society shall turn in the long-term development of the problems of the treatment of disease, for dental caries or cavities, is a disease.' And they ask: 'Shall it be the government, or shall it be the individual?'

In their brief, appellants urge that there is a distinction between public health and private health and pointing to the differences, they say: 'Contagious and infectious disease, anything that may affect others than those immediately involved, clearly involve public health. But if we have a headache from sinus, a backache from lumbago, or a toothache from caries, it is a question of private health that cannot involve anyone else.' While there are several important questions that were treated with in the trial below, this contention of the appellants quite clearly defines the issue and suggests the question of the limit of the duty in a community's providing proper regulation not to extend beyond that reasonable interference which tends to preserve and promote preservation of the health of the residents. * * * *

" 'The learned trial judge was of the opinion that the issues presented upon admitted material facts are:

" 'Where no question of infectious or contagious disease is involved, does the city of Milwaukee possess the authority under its delegated police power to introduce fluorides in the water supply for the purpose of reducing the incidence of dental caries in children and thereby also increasing the resistance to caries in their later life and, by substantial compulsion, in the necessity of most of its inhabitants to drink such water, to compel its inhabitants to accept medication, especially where it has a beneficial effect only upon a minority, although a substantial portion of such inhabitants?'

"He ruled that although a city may act in a proprietary capacity in owning and operating a water utility, the relation between the city and its inhabitants and its officers is governmental, even when the officers are performing duties which relate to the management of the city. And he said: "In the performance of its duty to promote and protect the public health, a city is not acting in a private or proprietary capacity, but purely in a governmental capacity in the discharge of one of the highest duties it owes to its citizens. *State ex. rel. Matrin v. Juneau*, 238 Wis. 564, 570 (300 N.W. 187).' The court recognized as controlling, evidence in the case which sustained the findings and supported the conclusion that a drinking-water supply regularly consumed between the first ten years of life containing a concentration of one ppm. of fluoride greatly inhibits dental decay, and recognized at the same time that the water supply furnished by the city was deficient in that element. While dental caries is not contagious, it is nevertheless a condition coming into existence and carrying its decaying effect to children and is generally recognized as a deteriorating element. When dental caries is recognized, as it must be, as a serious and wide-spread disease, a reasonably designed measure to decease or retard the incidence thereof is in the interest of the welfare of the public. It is recognized that the disease is active primarily in the formative years of child life; still the benefits derived as a result of preventing that disease carry through a substantial part of adult life. * * * *

"We agree with the decision of the court below denying the injunction, because it is within the province of the legislative authority to enact such measures in the interest of promoting public health and welfare, even though the act to protect general health is not based strictly upon an infectious, contagious, or dangerous disease. Well-reasoned precedents sustain the right of municipalities to adopt reasonable undiscriminatory measures to improve public health even though no epidemic or dangerous disease is involved. * * * *

"The objections are not based upon the claim that the program as outlined by the city will cause injury. It is rather based on a difference in policies with relation to necessity as an approach to the subject causing different standpoints. * * * *

"Because a public health measure has been enacted and the subject bears a real, substantial, and reasonable relation to the health of the city, there is no unreasonable invasion of the rights of the individual or of 'the right of parents to bring up and care for their children as they deem best,' or of any of the rights set forth by the plaintiffs in their complaint. * * * *"

Ed. Note: In the next (October) issue will be found Part 2 of this two part discussion of "The Legal Aspects of Water Fluoridation".)

1956 AWWA Conference Report—II

Purification and Distribution Division Sessions

THE FOLLOWING report completes the story of AWWA Diamond Jubilee meeting in St. Louis, Mo., May 6-10. The July issue covered the business and entertainment and general features of the meeting; the August issue covered five technical sessions. This report covers the remaining technical sessions.

Purification Division*

Two sessions were held in the Purification Division. In one of these, a panel discussion was held on the State Sanitary Engineers Manual. The panel discussion is reported later with other Division Discussions of the same subject.

Lime Softening Stabilization

H. O. Hartung, Supt. of Production, St. Louis County Water Co., St. Louis, Mo. reviewed his experience with "CALCITE STABILIZATION of LIME SOFTENED WATER".

Precipitation of supersaturated calcium carbonate from lime softened water may be accomplished in several ways. Filter sand will remove this hardness, with attendant increase in sand grain size and filter bed depth. Carbon dioxide is used in many plants to form the insoluble carbonate, however operating and maintenance costs may be high. Complex phosphates will stabilize the treated water under certain conditions and have found wide use.

Mr. Hartung reported progress to date on a basic study of the problem utilizing the dynamics of the equilibrium reaction. The previously softened water is passed through an upflow basin charged with 200-325 mesh calcite (calcium carbonate flour). It would be expected that calcite would encourage stability by contact with the water saturated with respect to calcium carbonate. This happened in 1941 laboratory studies where 20 to 30 minute contact periods reduced the alkalinity by 17 ppm.

However, in translating the process to a 6 mgd pilot scale plant, certain problems arose. A square accelator was installed but sludge accumulated in the corners, so circular plates were installed. Mechanical problems were encountered and it was learned that the calcite must be recirculated about 20 times the input rate. Another important finding was that correctly sized calcite is difficult to obtain. Estimated cost of the process is about $1.00 per mil gal. This is equivalent to recarbonation costs, but data indicate the calcite process to be more efficient and particularly adaptable with waters low in magnesium.

Whatever stabilization process is used, filter sand and the distribution system must be protected.

H. O. Hartung

V. J. Calise

F. G. Gordon

Purification Division

Mr. Hartung's paper was discussed by V. J. Calise, Technical Director, Graver Water Conditioning Co., New York, N. Y.

The discussion pointed out that the problem is to produce clear water. This is not difficult on warm water, some well water and water low in magnesium. However, some foreign compounds such as synthetic detergents interfere with any precipitation process.

Among the factors which should be studied, Mr. Calise included the effect on turbidity removal at high treatment rates and comparison of calcite treated water with pre-settled (turbidity removed) water. Mr. Calise suggested that some calcite might dissolve, together with particle size increase. This would complicate the problem of particle size control. The calcite process should be applied to soft raw water and filter backwash characteristics should be studied. Finally, Mr. Calise pointed out that since properly sized calcite is not commercially available, perhaps the correct particle size could be "created" within the treatment plant.

Discussors from the floor included Dr. A. P. Black of the Univ. of Florida, who stated that softened water stabilization is not a simple problem. Fundamental concepts of particle charge and charge magnitude will probably be shown in the final analysis. M. E. Rew, City Water Works Manager, Council Bluffs, Iowa reported successful carbonate sludge recirculation in a conventional type plant. M. L. Riehl, Mahoning Valley Sanitary District, Youngstown, Ohio asked for cost comparison between the calcite process and filter rebuilding. Mr. Hartung stated that water from the calcite process is not theoretically stable. Sand grains grew from .44 to 1.2 mm in 10 years, requiring sand re-sizing each four years.

Another report in the endless search for algicidal agents was presented by C. M. Palmer, Research Biologist, U.S. Public Health Service Sanitary Engineering Center, Cincinnati, Ohio. His paper "NEW ALGICIDES" discussed numerous chemical combinations of metallic irons and chlorine. Organic zinc and organic iron were found effective against blue-green algae in low dosages, but exhibited toxicity to fish. Modified copper (copper citrate) and modified chlorine compounds (chlorine dioxide, chlorine-ammonia) are characteristc of the items reported, none having general algicidal properties.

In summary, some chemical groups look promising, though probably more costly than copper sulfate. Their use would be indicated for selective kill of a particular alga. No completely new algacide, ready for use, has been developed.

Sludge Removal

The "ECONOMICS OF SLUDGE REMOVAL" by Fred G. Gordon, Asst. Chief Engr., Bureau of Engineering, Chicago, Ill., provided data strictly applicable to double deck parallel rec-

* These Purification Division sessions were reported by Virgil W. Langworthy, Project Engineer, Omega Machine Co., Providence, R. I.

tangular settling basins, operationally exceeding plant design capacity at extremely variable rates. A comparison was drawn between basins equipped with mechanical sludge removal equipment and basins cleaned by hand. Complete sludge removal equipment at the South District (Chicago) plant would reduce time out for cleaning basins from 20 per cent of the year to less than 4 per cent.

The paper reported that plant operation was not affected by sludge accumulation between hand cleanings. Filter runs depend directly on the number and type of micro-organisms in the settled water.

Complete sludge removal equipment installed at this plant would increase net annual operating expenses and fixed charges by an estimated $72,400.

The "COLIFORM LIMITS FOR RAW WATERS" was the title of the paper by Graham Walton, USPHS Sanitary Engineering Center, Cincinnati, Ohio. Mr. Walton stated that the U. S. Public Health Service Standards for potable water supplies are based in part on work accomplished during the period 1923-29 by Streeter and his associates. Stream pollution abatement programs have advanced and treatment processes have improved. A survey of 50 water treatment plants, however, showed that laboratory practices were not consistent with provisions contained in the standards. Bacteriological testing media was too weak, or wrong media was being used. Distilled water and tap water containing chlorine were used instead of saline solution for making dilutions.

Coagulation, sedimentation and filtration were found not reliable, indicating that disinfection is required. These data confirmed Streeter's findings of nearly 30 years ago. Heavily polluted raw water may be treated satisfactorily if disinfection is practiced. Plants should be equipped with standby chlorination equipment, properly located. Sampling should be frequent and an alarm should be provided with chlorine residual recording equipment.

Diatomite Filters

G. R. Bell, Johns-Manville Research Center, Manville, N. J. reported on "DIATOMITE VERSUS CONVENTIONAL FILTER PERFORMANCE". Mr. Bell stated that lack of design standards for diatomite filter equipment prompted the studies in his paper. Costs for operating the diatomite filter plant at Manville were between $165 and $168 per mil gal for the period January 31, 1955 to January 31, 1956. Operating costs depend on chemicals required for pre-treatment, power and backwash water required.

Comparative cost data for a 2 mgd plant were reported to be as follows:

Rapid sand filter plant—$296,500
Diatomite direct (no pre-chemical treatment)—$161,600
Diatomite plant including pre-chemical treatment—$201,800

J. M. Jester

V. C. Lischer

F. E. Dolson

L. P. Sudrabin

Distribution Division

Water Distribution Division

The Distribution Division held two regular sessions and also discussed the State Sanitary Engineers' Manual (see later section of this report).

Booster Station Control

Marvin H. Owen, Sen. Mech. Engr., Dept. of Water & Power, Los Angeles, Calif. read a paper on the "CONTROL OF BOOSTER STATIONS TO SERVE AREAS REQUIRING SECONDARY PUMPING." The paper dealt with the particular problems of Los Angeles where, because of rapid growth since World War II, there has been an accelerated demand for secondary pumping stations. Water is delivered at elevations from sea level to 2440 feet. There are 53 secondary pumping plants requiring more than 23,000 horsepower.

Mr. Owen covered plant controls from a simple float switch to a complex system handling up to seven units in a single plant, as well as automatic control of 600 horsepower synchronous motor driven units. Also covered in the paper were automatic internal combustion engine driven standby units and special cases of control where water hammer is a problem and pumps are started and stopped against a closed discharge gate.

Diagrams were shown for various methods of control whereby pumps are started in rotation, build up to maximum capacity and shut down in the reverse order. Pressure flow and time control systems were also illustrated.

The purpose of a highly developed system of controls is to provide a high reliability of water supply. This objective has been reflected in the basic design of all 53 pumping plants. All equipment was selected to operate well below its maximum capacity. Where water storage is limited, self-contained internal combustion engines are provided as standby power.

Obviously, a single control system cannot be used for all plants; each is a separate problem, but standardization of equipment has been used with a great saving in installation costs. Automatic pumping control shows a great economical advantage over manually operated plants.

Centralized Load Dispatching

"CENTRALIZED LOAD DISPATCHING EXPERIENCE" was the title of the paper by J. M. Jester, Maint. Engr., and J. W. Henderson, Elect. Engr., Washington Suburban Sanitary Commission, Hyattsville, Md. Mr. Jester presented the paper, which described the area served and the problems involved.

The Washington Suburban Sanitary Dis. serves 500,000 persons with filtered water from an impounded reservoir source. Since elevations vary from sea level to 660 ft, both booster stations and pressure reduction is necessary.

Pumps are controlled by Tank-Trol or Rota-Trol elements with a multiple telemetering transmission system using cyclic time impulses. Where surge problems exist, time delay relay devices are used. Rotating program timers are employed.

Mr. Jester described details of operation and problems of surge and water hammer. All data are telemetered to a central dispatching station. Problems have been of a minor nature in the telemetering equipment; spring loaded items need adjusting.

Demand and Penalty Rates

Vance C. Lischer, Cons. Engr., Horner & Shifrin, St. Louis, Mo. presented a paper on "PROBLEMS IN THE PURCHASE OF WATER THROUGH DEMAND OR PENALTY RATES."

The current trend toward urban population shifts to suburban areas has created demands for wholesale water from the parent metropolis. In many cases this water has been billed at commodity rates but the recent drought years have demonstrated the inadequacy of commodity rates as the only basis of payment. To overcome this inadequacy, rates with demand charges or penalty features have been invoked.

The problems involved depend on the particular system, its storage facilities and whether or not the outside system has storage facilities of its own. Range of supply must be provided for both wet and dry season. Usually the wholesaler must provide a meter (of low head loss). Unfortunately there is no well established demand meter now; one can be made but it is not satisfactory for several reasons.

The purchaser must provide a means of measuring the rate but this is difficult with standard components. Mr. Lischer suggested five ways of effecting the control desired.

(1) Standard rate-of-flow controller and time switch for changes through the day.

(2) Standard rate-of-flow controller (air operated) with a cam to fit the flow pattern.

(3) Two separate rate controllers and time switch with changeover arrangement.

(4) Time control during period of average rates and other means of control during critical periods.

(5) Synthetic pattern for rotation of spindle of meter.

The paper described an installation with cam-set, air operated rate control embodying a rate control variation from 50 to 2,000 gpm. The control is quite flexible in that a 24 hour cam can be cut to any shape desired; the cam being the replica of the 24 hour instrument chart. The cam paces the rate controller and the output of pumps is controlled by means of an air operated butterfly valve.

In this particular station, pumps can be started and stopped remotely from a treatment plant in the system being served which is the major source of supply. The cam device with its throttling control prevents the rate of flow exceeding the cam setting regardless of the number or size of pumps in operation.

Surge Control

Frank E. Dolson, Supt. of Distribution, St. Louis County Water Co. presented a paper on "Surge Control on Transmission Lines." In this paper, he showed the system involved and he gave a descriptive not a theoretical analysis of water hammer. In conduits with branches these surge waves become quite complex. In pump discharges, many factors affect surge wave patterns. Considering all of these factors, his department had been conservative in designs to handle the problem.

Both surge control and relief valves are used with slow operating vacuum and air relief valves at the critical profiles. The paper was illustrated with slides showing the design and layout of the equipment. Mr. Dolson described one surge sequence and the damage resulting.

Purification Division Panel

P. F. Morgan W. W. Aultman E. H. Aldrich C. W. Klassen

Steel Pipe

The "Behavior of Steel Pipe Under Earth Loads"* was presented by R. E. Barnard, Advisory Engineer, Welded Pipe Sales, Armco Drainage & Metal Products, Inc., Middletown, Ohio. In the pioneering days, wagon trains were formed into circles for safety when in danger of attack. Buffaloes did the same thing, but an individual buffalo knew only that the next buffalo was protecting him on each side. He wasn't aware of the rest of the ring.

Mr. Barnard likened the engineer concerned with steel pipe design to the buffalo, under such circumstances. One engnieer might design basically or largely on laboratory test results, another on the structural strength of flexible steel rings, or other individual factors such as manufacturing processes, photo-elastic properties, foundation studies, characteristics related to soil mechanics, measurements of steel in underground use, etc. A mathematician is required to put all of these factors together to accomplish a complete design.

Many engineers are unaware that the effective roughness of a pipe varies with the diameter. Most engineers consider the shell of a steel pipe to be an engineering material, but not the earth envelope around it. They must recognize that the steel ring, concrete and the earth envelope all represent a couplex structure.

Mr. Barnard showed slides of stress patterns, largely microphotographs from tests on steel rings embedded in plastic. He referred to tests at Chapel Hill, where pipe was placed under cover of sand and measured deflections were taken with different depths of cover. Calculated deflections based on his theory were very close to measured deflections.

Data for the foundation of Mr. Barnard's paper will be included in the new steel pipe manual being prepared by the AWWA. It involves four formulas, two tables and eight diagrams. The manual should be out by the end of this year. Mr. Barnard pointed out, in answer to a quetsion, that the theory would not apply to cast iron pipe.

"Soil Mechanics and Trenching Practices was discussed by Henry Reitz, Acting Head, Civil Engineering Department, Washington University.

Mr. Reitz defined soils as to types of soil particles; (1) bulky particles and (2) platy particles. Bulky or coarse type soils have the general shape, rounded or angular and have single grain structure. Platy particles are made up of laminations, mica flake is good illustration.

Specific surface in bulky particles is low and is high in platy particles; it is the ratio of surface area to particle mass.

In any particular soil, the properties are basically bulky or platy type. For instance, sand is bulky particle type and clay is platy particle type. Relative densities are important in compaction of backfill. Mr. Reitz illustrated his paper with slides.

Corrosion

The "External Corrosion Problems in the Water Distribution System" were discussed by Leon P. Sudrabin, Director, Engineering

* This paper and the following two papers were reported by Wallace Miller Research Engineer, Cast Iron Pipe Research Assn., Chicago, Ill.

Services, Electro Rust-Proofing Corp., Belleville, N. J. Mr. Sudrabin classified corrosion by types: (1) Stray current and (2) Galvanic corrosion system in which galvanic flow is caused by the corrosion product.

In Stray current corrosion, loss has been determined for Fe as 20 lb per ampere per year. Stray currents may be caused by: Railway systems, underground electric services, cathodic protection systems on other pipe lines, and DC welding machines. Correction of stray currents may be accomplished by elimination, collecting or bonding (drain back), galvanic anode (cathodic protection), sectionalizing pipe into small sections (if stray currents not too great).

Cathodic protection is becoming very prominent. There are so many rectifiers being installed and there have been many instances of harmful effects. Mr. Sudrabin encourages cooperation with engineers putting cathodic protection on lines for other utilities. These engineers want to cooperate and not hurt the water utilities. It will not cost much to cooperate and to make necessary adjustments. The damage from AC current is only 1 per cent of the damage from DC current. We should not ignore AC but Mr. Sudrabin does not believe it will represent any particular problem.

In respect to dissimilar metals—Mr. Sudrabin stated that variations on the surface of a ferrous pipe line can be more of a problem than dissimilar metals. He believes best practice is a well applied coating (AWWA Spec.) and to apply protective current for any flaws in the coating. He is finding more evidence of coatings not being well applied. Cathodic protection is not completely effective under these conditions.

In the discussion which followed Mr. Sudrabin answered many questions, some of which are included here:

Quest.—Would he recommend cathodic protection on a new coated steel pipe line?

Ans.—Yes. His Committee (TP-2 of NACE) will soon release a recommendation for cathodic protection, even though coated.

Quest.—Would he clarify—cathodic protection on all steel pipe lines—regradless of soil, coating, etc.?

Ans.—Mr. Sudrabin said he desired to hedge a bit. He usually deals with steel lines for oil and gas, where breaks are more of a problem and state agencies are showing greater concern. He pointed out the minor nature of operating costs, possibly as low as $5.00 per mile per year. Under some conditions, such as a bare line, etc., it might represent a very expensive operating cost.

Quest.—Was he in favor of bonding joints?

Ans.—Yes, generally. Perhaps in a few cases, no. A pipe line does not adapt itself to protective measures unless connected. Long line corrosion is easy to stop—local cell action is difficult.

Quest.—Would he please comment on prestressed concrete pipe?

Ans.—He was not sure this was corrosion free. He has had some indication of corrosion. He knows of cases where the concrete has fallen away, then the steel surface is easily corroded. The big problem on concrete pipe is to have the metal adequately bonded so that protection may be provided (continuous metallic structure). There may be a day when corrosion protection will be required. He spoke of the type where the metallic structure included a continuous circular wire which might represent many miles of resistance.

Quest.—Is local cell action improved by sand blasting or shot blasting?

Ans.—He doesn't think so. He finds the penetration of corrosion is greater after sand blasting, even though the rate of corrosion is the same.

Quest.—Is cathodic protection effective against sulphur reducing bacterial action?

Ans.—Yes.

Quest.—Would he comment on the practice of laying pipe on wooden blocks?

Ans.—He has observed instances of corrosion of steel pipe laid on wood block, but not cast iron. The wood provides a shield from the air, just the same as a root against the pipe. This encourages sulphate reducing bacteria. He doesn't like the practice—wood or organic matter of any kind. He cited an incident of a friend who had radiant heating, with copper tubing. Part of the tubing rested on wood strips. There was severe corrosion and failure of the copper tubing at these points.

C. H. Bechert

L. J. Alexander

B. A. Poole

Resources Division Panel

Sanitary Engineer's Mannual

Each of the four divisions held a panel discussion on the Manual prepared by the Great Lakes-Upper Mississippi Board of State Sanitary Engineers. Each panel included a state sanitary engineer, a consulting engineer and a representative of a private or public water works property.

Water Purification*

In the Water Purification Division, the panel was moderated by Philip A. Morgan, Prof. of San. Engr., University of Iowa, and included W. W. Aultman, Cons. Engr., Pasadena, Calif. E. H. Aldrich, Chief Engr., American Water Works Co., Inc., Philadelphia, Pa., and Clarence W. Klassen, Chief Sanitary Engineer, State Health Dept., Springfield, Ill.

Mr. Aultman, as a consulting engineer, believes the manual will be valuable if the limiting values are valid and if the administrative recommendations are based on sound, modern concepts.

The limiting values provided, he believes, are not necessarily up to date and appear to be conservative. While they should prove helpful to young engineers, limiting values are subject to local conditions. The manual should not be inflexible.

Aultman believes the manual should exercise semantic care. He suggests changing "shall" and "will" to "should" and "would". The manual should not dictate procedures to engineers. "Water is fluid—regulations should be fluid" he said. Finally, Mr. Aultman suggested expansion of the advisory staff to include national, as opposed to regional, representation.

* Reported by V. W. Langworthy, Project Engr., Omega Machine Co., Providence, R. I.

The manual perhaps should be a joint society project.

Provisions of the manual as they effect the operator were discussed by Mr. Aldrich, who questioned the reasons for State Authority review of plans and specifications. Originally, public health protection made such review mandatory. However, the task of reviewing authorities and the number of "watchdogs" should lessen as water treatment knowledge is gained, he said.

He agreed with Mr. Aultman about limiting values. Health, safety and public convenience aspects must be met by each water facility. The manual should remain advisory only and not dictate.

Mr. Aldrich's company operates 100 water systems in several states. The need for uniform requirements does not exist in some cases to eliminate conflict with U. S. Public Health Service standards. He suggested the manual be used as a universal reference, that reviewing authorities eliminate requirements for approving minor plant alterations and that economics be borne in mind at all times.

C. W. Klassen, defended the manual as a state sanitary engineer. He indicated that of the engineers hired, 10 per cent are not qualified to design structures for jobs to be done. If these engineers followed the elemental suggestions of the manual, man-hours would be saved and resubmission of plans would be minimized.

He indicated that Illinois state engineers do consider local conditions when reviewing proposals. The manual was drawn up by midwestern engineers and he questioned whether such a guide could be practical on a national scale.

The discussion period was lively. Among the important points brought out were Mr. Klassen's suggestion to eliminate incompetent consulting engineers. He stated that engineers should confine their activities to their own profession, and only qualified consultants should be retained by utilities and that equipment companies should refrain from encouraging and assisting engineers of questionable capabilities.

Water Resources*

In the Water Resources Division the panel was moderated by C. H. Bechert, Dir., Div. of Water Resources, Indiana Dept. of Conservation. The panel included Louis J. Alexander, Vice Pres. & Chief Engr., Southern California Water Co., Los Angeles, Calif.; Samuel B. Nelson, Chief Engr. Water Division, Dept. of Water and Power, Los Angeles, Calif. and B. A. Poole, State Sanitary Engineer, Indianapolis, Ind.

The purpose of this group was to evaluate those sections of the Manual which deal with water supply design standards with reference to both ground and surface water supplies.

The section on surface water sources was reviewed Mr. Nelson. He considered this section of value to the practicing engineer as a check system to assure full consideration of a problem. A warning was offered, however, that care must be taken to assure that guide posts do not become thought barriers. Water rights and supplemental irrigation are matters not discussed in the design standards but should be included because of their ever-increasing importance.

The section on ground water sources was covered by Mr. Alexander, who called attention to the fact that, as a westener, he was somewhat concerned that he should be called to review a mid-West water supply guide.

The "manual" has been adopted by the Utah State Department of Health as a guide. Widespread interest in the development of a water supply design manual was said to exist. It was suggested that such a manual might well be jointly sponsored by the American Water Works Association and the American Society of Civil Engineers.

The group's discussion was completed by B. A. Poole, who indicated that an Upper Mississippi and Great Lakes group will start a revision of the "manual" in the near future and will make full use of the detailed and general comments of these various panels. He said that he was in complete agreement that the "manual" should be used as a guide-post and that his colleagues assured him that this is the practice. Qualified consulting engineers should have discretionary powers in design of water supply works, he said, but there are others who can not be allowed to run loose on the range." Experience supports this stand.

The need for a chapter on water rights was acknowledged, but because of the "state of flux" on water rights, it was said to be impossible to write a section for 10 states. This must be done on a state-to-state basis.

Mr. Poole completed his remarks by saying that the practicality of the preparation of a nationwide water supply design document should be investigated very carefully before definite action is taken.

Water Works Management*

In the Water Works Management Division the panel discussion was moderated by N. S. Bubbis, Gen. Mgr., Greater Winnipeg Water and Sanitary Dist., Winnipeg, Can. Panelists included Paul Haney, Cons. Engr., Black & Veatch, Kansas City, Mo.; Melvin P. Hatcher, Director of Water, Kansas City, Mo.; and Russell L. Culp, Chief, Water Supply Section, Kansas State Bd. of Health, Lawrence, Kans.

Management Division Panel

P. D. Haney M. P. Hatcher R. L. Culp

Mr. Culp pointed out in his paper that Kansas has had 49 years experience with laws requiring State Board of Health approval of all reports and plans and specifications for water works improvements. Also in 1953 the Health Board compiled and published a book of standards for water works design. This publication has materially reduced the need for preliminary consultation with engineers and the need for repeated changes in plans and specifications and the net result of this use has been quite satisfactory.

He says the scope of any such manual should be limited to matters having a direct effect on the sanitary quality of the water and that the key to the success of the manual under discussion would be its interpretation and administration. It should not be

* Reported by David H. Howells, Sen. San. Engr., U S P. H. S., Chicago, Ill.

* Reported by M. P. Hatcher, Div. of Water, Kansas City, Mo.

allowed to become a rigid, permanent set of standards.

Paul Haney stressed the points that "what the manual says is of much less significance than how the policies established by the manual are administered" and that the "manual should serve as a compendium of criteria, that is, as a guide rather than a set of rigid rules or standards".

Melvin Hatcher pointed out the uncertainty that attended the assignment of the subject to the panel,—his main point being that the review of the manual did not extend to its general conformance to the laws governing the state health division's approv-

Distribution Division Panel

R. G. Kincaid L. S. Finch G. W. Moore

al of plans and specifications for water works improvements, and that any discussion of details was almost purposeless without the broader background. He saw nothing in the manual that was not inherent in the rules and regulations governing the operations of the individual state sanitary engineers.

N. T. Veatch, consulting engineer of Kansas City, Missouri expressed the fear that the manual would set up as rigid standards of design and would lead to sharp differences between consulting engineers and the state boards of health. One discussion from the floor was aimed at the lack of opportunity by others to review the manual so that they could see how they were affected by it. The reply to both of these points was made by W. J. Downer, Assistant Chief Sanitary Engineer of the State Board of Health of Illinois. He made the point that the manual should not be made a rigid set of standards and that the manual had not had general distribution for the reason that only 200 copies had been printed, and that the Great Lakes-Upper Mississippi group thought of the standards as still being in tentative form.

Water Distribution*

In the Water Distribution Division, the panel discussion was moderated by F. E. Dolson, Supt. of Distribution, St. Louis County Water Co., St. Louis, Mo. Panelists included Russell G. Kincaid, Cons. Engr. Burns & McDonnell, Kansas City; L. S. Finch, Vice Pres. and Chief Engr. Indianapolis Water Co., Indianapolis, Ind.; and George S. Moore, San. Engr., N. Y. State Health Dept., speaking for Earl Devendorf, Dir., Bur. Engr. Sanit., Albany, N. Y.

Mr. Kincaid led off with a discussion of the manual from the viewpoint of the consulting engineer.

The non-conformity of state standards on water system design was described as working a hardship upon consulting engineers and equipment manufacturers and sales engineers doing business in several states. Accordingly, the consulting engineer was said to be in favor of standardization of state policies and regulations. This opinion was tempered by the remark that a consulting engineer's principal concern regarding state standards is that he be given the maximum latitude consistent with good practice in the design of water supply systems.

The detailed standards were not considered necessary for the experienced engineer, and the question was raised whether rules and regulations can be made sufficiently voluminous to insure that the inexperienced engineer will ever come up with more than a mediocre design. The solution to this problem was thought to lie in a strengthening of present state engineering registration laws. Until this is accomplished, not much hope was held for the simplification of the "manual."

Earl Devendorf's comments regarding the consulting engineer's viewpoint were presented by George Moore, New York State Department of Health. He agreed that plans submitted by poorly qualified engineers constitute a problem for state sanitary engineers, who would be greatly relieved of many unnecessary hours of detailed review and revision of plans if there were any practical way of obtaining the desired objective by having only experienced water works engineers submit plans and specifications.

The "manual" was developed largely to set up guides as to minimum requirements for water works design. Departures from these requirements are subject to the submission of supporting information and data.

The Great Lakes and Upper Mississippi River Board of State Sanitary Engineers has authorized each of the water supply sections of the various states to meet this year to consider changes which seem advisable. Constructive suggestions for modifications will be helpful in making the proposed revisions.

The discussion by Lewis S. Finch, (a former State Sanitary Engineer) was from the viewpoint of the water utility engineer. It included the same expression of concern over the use of the "manual" by inexperienced engineers as voiced by other panel members. In addition, many detailed suggestions were made to supplement or clarify the text. It was his opinion that the statement of principals and standards in the "manual" should provide a most worthwhile means of securing uniformity in the requirements of the State Boards of Health in the ten states involved.

* Reported by David H. Howels, Sen. San. Engr., U S P.H.S., Chicago, Ill.

Weston, Eckenfelder & Associates Enlarge Staff

Weston, Eckenfelder & Associates have found it necessary to increase their technical staff by two as the result of their rapidly growing consulting work.

Walter T. McPhee and Robert Kleffman have recently joined the organization—Mr. McPhee as a member of the firm and Mr. Kleffman as staff member.

McPhee has since 1948 been associated with Malcolm Pirnie Engineers in a variety of undertakings in water, sewerage and waste problems. He is a 1943 graduate of Manhattan College and received a M.C.E. degree from New York University in 1949. Prior to joining Malcolm Pirnie Engineers, he was associated with Prof. Clarence Velz in stream pollution studies, and later with Parsons, Brinknhoff and McDonald of New York City.

Mr. Kleffman is a 1956 graduate of Manhattan College, majoring in Sanitary Engineering.

WATER WORKS PRACTICES

Disinfection—Part I

Water Borne Disease, Bacteria, Disinfectants

The thirty-third of a series

by GEORGE E. SYMONS, Ph. D.

Dr. Symons is a Consultant and Technical Editor in Larchmont, N. Y. In this series he discusses *Water Works Practices* in the form of short school lectures, designed to assist operators, students and others who wish to review fundamentals in this field.

THERE IS AMPLE historical evidence that as early as 2000 B.C., man recognized that some waters had an adverse affect on his health. Sanskrit writings indicate that storage of water in copper vessels, exposure to sunlight, filtering through charcoal, and boiling were recommended for treatment of "foul waters".

It was not until 1860-70 when Pasteur had laid the ground work for the germ theory of disease, that water as a carrier of disease could be fully understood although the epidemiological relation between water and disease had been suggested as early as 1854.

In order to present a complete discussion of disinfection in water works practice, it is necessary to know something of water borne diseases, of the bacteria in natural waters, and of means for destroying bacteria. This lecture is devoted to these topics.

A . . . Water Borne Diseases

1 . . . Cholera

a. Asiatic cholera is a most dreaded disease caused by the ingestion of water or food containing cholera vibrio.

(1) The bacteria, discovered by Koch in 1884, are easily killed by one hour's sunlight, heat, acids, and other disinfecting chemicals, but the disease has circumnavigated the world several times.

(2) At four different periods in the 19th Century, cholera was pandemic and more than 10,000 persons died yearly from the disease.

. . . In the 1860's there were large death tolls in the United States.

. . . Between 1820 and 1910 there were seven epidemics in the Philippine Islands, with deaths reaching 1000 per day in Manilla alone.

b. Symptoms of the disease are cold, clammy sweating, severe vomiting and diarrhea, an unquenchable thirst, severe cramps in the calves and legs and a gray color to a shrinking skin.

c. The effects of the disease are caused by a toxin produced by the bacteria. The toxin is quite fatal and kills with the swiftness of strychnine.

d. Two famous cholera epidemics are significant in the history of water supply.

(1) Broad Street Well epidemic in London in 1854. This resulted in the first epidemiological study of the relation of water supply to disease.

. . . Dr. John Snow was able to show that the source of the disease was this particular well which had become contaminated from a visitor, who had arrived in the vicinity with the disease.

. . . When asked "how can we stop this cholera epidemic?" Dr. Snow replied, "Remove the pump handle!", but this theory was not accepted and he had to publish the account of his discovery at his own expense.

(2) The Hamburg-Altoona, Germany epidemic of 1892 when iterants with chlorea, camping at a pier upriver of these two towns, polluted the river water.

. . . Hamburg with a filtered water supply developed no cases of cholera; Altoona with no filtered supply developed a severe cholera epidemic.

. . . Proof of the relation of water supply to the disease was doubly demonstrated when one square block in Hamburg, served by the Altoona supply, developed cholera cases.

2 . . . Typhoid Fever

a. Once the most important water borne disease in America, it is rapidly disappearing, and few cases are reported today.

b. Cause of the disease is the bacterium Eberthella Typhi, which has a relatively long life in fairly pure water but is easily destroyed.

c. Dramatic evidence of the reduction of typhoid fever incidence with water disinfection was exhibited in the sudden and marked decrease in case and death rates in Chicago and Niagara Falls, N. Y. when chlorination was adopted as a treatment.

d. Present day sources of the disease are generally found in human carriers, flies with access to open plumbing, milk and food.

(1) About 4 per cent of typhoid patients remain carriers.

. . . The most famous carrier was "Typhoid Mary" Mallon, who as a cook in New York City is believed to have caused 49 deaths. Dr. George A. Soper discovered and reported this case history.

(2) Fly borne epidemics usually occur in late summer, whereas water borne epidemics are usually in the early summer.

(3) Where milk or food is involved, the source is likely to be a carrier or may be one of these.

. . . Unclean utensils or utensils washed in polluted water.

. . . Oysters "plumped" in polluted fresh water.

. . . Fresh vegetables grown where sewage is used for fertilizer.

3 . . . Dysentery

a. Dysentery and its accompanying diarrhea may be caused by two different organisms, both of which may be either water borne or food borne.

(1) Amebic dysentery (amebiasis) is caused by Entamoeba Histolytica, a slightly greenish microscopic unicellular parasite.

(2) Bacillary dysentery (shigellosis) is caused by a bacillus and is both less severe and less likely to be fatal than amebic dysentery.

b. The most famous epidemic occurred in Chicago in 1933 during the Century of Progress World's Fair.

(1) Plumbing inadequacies and leaks into the water supply of the Congress and Ambassador Hotels resulted in many cases of amebic dysentery and 23 deaths, one of which was the Texas Guinan, famous entertainer of the speak-easy era in New York City.

(2) Only two other epidemics of amebic dysentery have been recorded in the United States. Both of them were also in Chicago but not in 1933.

4 . . . Intestinal Enteritis

a. Other gastro-intestinal infections which result in diarrhea and sometimes vomiting have been credited to the presence of Paratyphoid organisms or the Salmonella group. These may be water or food borne.

(1) Sudden sharp outbreaks of diarrhea and vomiting sometimes called "24 hour flu" have been suggested as caused by a water borne virus not destroyed by common disinfection practices.

(2) Epidemics of this type have occurred along the Ohio River, in Buffalo, N. Y. (in 1939) and at Niagara Falls, N. Y. in 1934 following severe pollution in the Niagara River as the result of the breaking of an ice jam in a heavily polluted tributary at Buffalo, N. Y. (before sewage treatment was inaugurated in that city).

5 . . Infectious Hepatitis

a. Epidemic jaundice or infectious hepatitis is caused by a virus that may be carried in water.

b. This disease which is quite severe was practically unknown (or at least unrecognized as water borne) in the United States until after World War II.

c. Most, if not all, of the reported outbreaks have been in camps and very small supplies, many of them in well waters.

6 . . Other Diseases

a. Although there is evidence that the virus of poliomyelitis or infantile paralysis is found in the stools of patients and in sewage, there is no epidemiological evidence that the disease is water borne through drinking water.

b. Some diseases and health problems may result from contact with water, bathing pools and beaches; these include schistosomiosis (swimmer's itch) and possibly histoplasmosis (a fungus disease).

7 . . Non Specific Diseases

a. Certain diseases or adverse health conditions result from drinking water containing or lacking in certain chemical elements.

b. Among these non specific diseases are:

(1) Goiter caused by low iodine intake.

(2) Metal poisoning, particularly lead poisoning caused by as little as 0.1 ppm of lead, dissolved from lead pipe by soft water containing carbon dioxide, oxygen or chloride.

(3) Diarrhea caused by high magnesium content waters.

(4) Constipation caused by high iron content.

(5) Fluorosis or mottled enamel in teeth due to high fluoride content.

(6) Dental caries resulting from low resistance of teeth to decay in the absence of fluoride in drinking water.

8 . . Protection Against Disease

a. The treatment of water supplies with coagulation, sedimentation, filtration, and disinfections or by disinfection alone has reduced the incidence of water borne disease to almost nil in public water supplies.

b. The improvement in general health in a community with the reduction of water borne disease was quite obvious in the early part of this century.

(1) This improvement was known as the Mills-Reincke Phenomenon and expressed as an equation:

$$[Ab = D]$$

where A = Decrease in death rates due to intestinal disease
b = 2 or 3
D = Decrease in general death rate

(2) Presently, water borne diseases are so insignificant that their occurence has little relation to the morbidity and death rates in this country. In underdeveloped countries, however, the Mills-Reincke Phenomenon is still evidenced when water treatment is instituted.

c. Non specific water borne diseases (e.g. lead poisoning) are not affected in any way by disinfection practices since they do not involve living organisms.

B . . . Bacteria in Water

1 . . Source

a. Some bacteria are native to water, the true water bacteria; others are found in water but are not indigenous to it.

(1) The latter may come from the soil, the air, or from human or animal wastes.

(2) In water works practice, it is the human waste bacteria with which we are concerned.

b. Bacteria are divided into three great groups according to their metabolism.

(1) Protatrophic forms have the lowest nutritional requirements, like the nitrifying bacteria which derive energy from carbon dioxide, nitrites, phosphates and ammonium salts.

(2) Metatrophic bacteria live on organic matter (both mitrogenous and carbonaceous) but do not depend on fluids of a living plant or animal.

(3) Paratrophic bacteria or true parasites which exist only in some living host.

c. Most bacteria are metatrophic, also termed saprophytic, but the divisions between these three groups are not sharply defined.

2 . . Importance of Water Bacteria

a. According to Prescott, Winslow and McCrady* there are seven types of bacteria found in natural waters.

(1) In water supplies only the coliform group is of major importance; this includes both pathogenic (typhoid, paratyphoid, and dysentery) and the non-pathogenic organisms.

(2) The infectious viruses (for example, infectious hepatitis) pathogenic ameba and pathogenic protozoa also are important in water supply treatment but are not usually found by the ordinary bacteriological testing techniques used in a water works laboratory.

b. Two criteria of water quality are the Agar Plate Count and the Most Probable Number (MPN) of coliform bacteria.

(1) The temperature, at which these tests are made, namely 37°C (approx. human body temperature) was chosen to rule out normal non-polluting soil and water bacteria which grow best in artificial testing media at about 20°C.

*"Water Bacteriology", 6th Ed., by Prescott, Winslow and McCrady, (John Wiley & Sons).

c. The coliform group of bacteria is used as an "indicator organism" in water works practice because as a group it meets the characteristics necessary for indicating the presence of human pollution in water.

(1) It is present in large numbers when pollution is present and absent when pollution is absent.

(2) It is easily isolated and identified.

(3) It has constant morphological and physiological characteristics.

(4) Except when typhoid or paratyphoid are included, the group as a whole is not pathogenic. (Usually the pathogens are harder to isolate.)

3 . . Self Purification

a. Surface water supplies evidence a phenomenon known as self purification, the degree of which is dependent on time and other factors.

b. Food supply is a limiting factor in bacterial growth as long as there is ample food supply, bacterial populations will increase, generally fairly rapidly if there are no other limiting factors.

c. Temperature has an important effect on the rate of growth of bacteria.

(1) Seasonal variations are quite marked; the bacterial population of a polluted water is much greater in the summer than in winter.

(2) The higher the temperature, the sooner the food supply is exhausted and the sooner the bacteria die off.

d. Direct sunlight will reduce the number of bacteria if the water is not turbid, but even then the effectiveness of sunlight is no more than a few feet of depth.

e. Natural enemies tend to place an upper limit on bacterial populations in streams and lakes or may even reduce bacterial numbers in time.

(1) Predatory protozoa such as Paramoecium will feed on bacteria and generally will place a maximum limit on the bacterial population and even reduce the numbers in time.

(2) Bacteriophage is a substance which destroys bacteria; it may be a virus or some end product of the bacteria themselves but when present the bacteria disappear completely.

. . . Certain rivers in India exhibit this antiseptic action, notably the Jumma, the Duele, and the Ganges.

f. Sedimentation will have an effect where the movement of the water is so slow that subsidence can take place.

(1) Storage of water in reservoirs produces a high degree of bacterial reduction.

(2) Where turbidity is present and settles out, it will carry bacteria down with it.

g. Chemical conditions play an important part in bacterial growth; aerobic bacteria grow only in the presence of dissolved oxygen; anaerobes grow only in absence of dissolved oxygen. Alkalinity and pH are important to bacterial growth, but except where industrial wastes affect these factors, natural conditions are usually fairly optimum for bacterial growth.

h. Time is always a factor in bacterial life cycles and in the factors which affect them.

(1) Storage allows sedimentation time and hence reductions of bacteria.

(2) Temperature and time are interrelated in bacterial life cycles; the warmer the water the more rapid the growth, the sooner the food supply is exhausted and the sooner self purification is accomplished and vice versa.

j. Dilution of polluted water with unpolluted water has two effects; an immediate decrease of bacterial numbers in direct ratio to the dilution factor followed by an increase in total bacterial population far above the original numbers.

(1) Experimenters at the USPHS laboratories in Cincinnati in the 1930's showed that when the polluted water is diluted the protozoa and other limiting factors are reduced thereby allowing the bacteria to overgrow the protozoa.

(2) Symons and Simpson* in studies on the bacterial condition of the Niagara River below Buffalo, N. Y., showed:

. . . Without disinfection of Buffalo sewage the number of bacteria introduced into the river in the sewage increase five fold in a distance of 7 miles and a flow time of 3¾ hours.

. . . When the Buffalo sewage is disinfected with chlorine and the coliform density reduced to approximately 1000 per ml., then the bacterial population of the Niagara River below Buffalo does not increase appreciably above the total load introduced by the treated sewage.

4 . . Permissible Loads

a. For water plants which rely on disinfection alone, Streeter—Jour. AWWA 31;1947(1939) stated that the average monthly coliform index in the raw water should be no more than 50 per 100 ml.

b. Where other treatment processes are also used, the permissible bacterial loading on the plant is 100 times that or more depending on conditions and processes employed.—See Lecture on Filtration Sect. C,7b.

5 . . Ground Waters

a. Ground waters, are generally free of coliform bacteria.

(1) Shallow dug wells, however, have a higher incidence of pollution than other ground waters, particularly if the wells are relatively near privies or cess pools.

(2) Ground waters often do contain appreciable numbers of slow growing soil bacteria, and some bacterial that will grow at 37°C but these have no sanitary significance.

b. Bacterial pollution of ground water depends on the type of soil, rainfall and height of ground water table.

(1) Coarse, rocky soils with fissures offer little barrier to the travel of bacteria into ground water.

(2) Sandy compact soils filter out the bacteria in relatively short distances.

. . . Studies in California on sewage reclamation by spreading sewage effluents for ground water recharge have indicated that alternate basin percolation of effluents with a B. O. D. of 30 ppm at 0.5 cfs per wetted acre in coarse gravel produces no contamination at 7 ft depths during one month periods.

D . . . Disinfection

1 . . Definitions

a. Antiseptic—A substance that opposes sepsis, putrefaction or decay; one that prevents or arrests the growth or action of microorganisms, either by inhibiting their activity or destroying them. The term is used especially of agents applied to living tissue and not to substances used in water treatment.

b. Bactericide—Any physical means or chemical substance that destroys bacteria.

c. Bacteriostat—A substance which prevents or inhibits the growth of bacteria, but does not necessarily destroy all of the cells.

d. Chemotaxis—The reaction of microorganisms toward a chemical.

e. Deodorant—A substance that destroys or masks offensive odors.

f. Disinfectant—An agent, either physical or chemical, that destroys practically all (but not necessarily all) harmful and objectionable microorganisms in or on a medium.

g. Disinfection—Process by which most but not necessarily all harmful

*Symons, Geo. E. and Simpson, R. W., "Bacterial Pollution of the Niagara River I & II"; JAWWA 31: 1156(1939); 32: 1529(1940).

and objectionable microorganisms are destroyed.

h. Germicide—An agent, either physical or chemical, that destroys germs (microorganisms); the term is applied particularly to agents that kill disease germs and is generally used in reference to household and personal disinfection practices.

i. Insecticide—A substance, particularly a preparation, used to destroy insects.

j. Sterilization—The act or process of sterilizing or freeing any medium from *all* living organisms.

2 . . Physical Agents

a. Microoganisms are susceptible to many physical agents because the cell structures are composed of protoplasm which cannot withstand certain degrees of physical effects.

b. Radiation

(1) Sunlight is harmful to bacteria but the exact cause of the effect is not known.

(2) Ultraviolet light is quite bactericidal and is used in some cases for water disinfection.

(3) X-rays are very bactericidal.

(4) Radioactive radiation is also bactericidal.

c. Temperature

(1) All microorganisms have an optimum temperature at which they grow best.

(2) Microorganisms are killed above certain individual maximum temperatures; some, however, go into a spore stage which requires even higher temperatures for destruction.

(3) Bacterial cells are more resistant to freezing than the cells of higher plants, but the number of cells killed by freezing will depend on the time, temperature and pH.

d. Other physical factors

(1) Experimenatl studies have shown that pressures of 6000-12000 atmospheres will kill bacteria.

(2) Violent agitation is detrimental to bacteria.

(3) Aeration actually aids growth (except of anaerobes).

(4) Gravity has little effect except as noted previously in the discussion of sedimentation.

(5) Electricity has little direct effect on bacteria in a liquid unless there is an electrolysis which produces some agent which is bactericidal.

(6) Ultrasonic waves with a frequency far above the audible range have been shown to be detrimental to bacterial cells.

e. Feasibility

(1) Radiation

. . . Sunlight is helpful in storage reservoirs but is not continuous and should not be relied upon for any definite part in disinfection of water supplies.

. . . Ultraviolet light has been used in several installations particularly in France.

. . . X-rays and radioactive emissions are not practical for large scale water treatment although it has been suggested that radioactive rays be used for both water and sewage disinfection.

(2) Induced temperature changes are not a feasible method of disinfecting water supplied, but boiling is highly recommended for household water use when the supply is of doubtful source or is known to have been contaminated as in the case of floods.

(3) High pressures, violent agitation and electricity are not feasible or practical in any sense for large scale disinfection, but ultrasonic waves have been under study particularly in sewage treatment and may be found useful except for the high power input required.

3 . . Chemical Agents

a. There are several important characteristics of a good disinfectant:

(1) High bactericidal power for all organisms.

(2) Stability; it should not be subject to decomposition and should not react with organic matter.

(3) Homogeneous composition; it should not form emulsions in water or separate into layers.

(4) Readily soluble in water in strength required for disinfection.

(5) Non-poisonous to human and animal life—This characteristic is almost impossible to find.

(6) Non-corrosive both in stored condition and in use.

(7) Penetrating ability with respect to cell structure.

(8) Free from taste and odor producing effects in the concentrations used.

(9) Moderate cost.

b. Chemicals effective for disinfection include:

(1) All halogens (fluorine, chlorine, bromine, and iodine) are effective in action against bacteria, but only chlorine and bromine are practical for use.

(2) Chlorine compounds wherein the chlorine is "available".

. . . Hypochlorites, particularly sodium and calcium hypochlorite.

. . . Chloramines produced by the action of chlorine on ammonia.

. . . Chlorine dioxide produced by the action of chlorine on sodium chlorite.

(3) Ozone produced by the action of electricity on air.

(4) Other chemicals such as phenols, cresols, polyhydroxyl phenols, the salts of heavy metals, etc., are not useful or feasible for the disinfection of water supplies but are useful for problems of disinfection in the household or hospital etc.

(5) Colloidal silver and other metals exert an oligodynamic action which kills bacteria but the process is not feasible for large scale use.

4 . . The Disinfection Reaction

a. Several theories have been advanced in the past to explain the action of disinfectants, both chemical and physical.

(1) Coagulation of cell protoplasm.

(2) Addition of chemical directly to chemical groups within the cell protoplasm thereby interfering with its life processes—Chlorine and oxygen (ozone) have been placed in this class.

(3) Altering the chemical environment in and around the living cell thereby creating conditions unfavorable to its existence, such as changing the pH both inside and outside the cell.

(4) Interfering with the enzymatic processes necessary to the life of the bacterial cell.

. . . Green and Stumph—JAWWA, 38: 1301(1946)—showed that chlorine compounds reacted with certain enzymes necessary to the metabolism of living cells and that death of the cells resulted from inactivation of the enzymes.

. . . It appears quite possible that this same theory applies to other chemical disinfectants and even to physical agents as well.

b. There are several factors which influence disinfection.

(1) Temperature—The rate of disinfection increases with temperature rise.

(2) Time—Disinfection is not instantaneous and becomes more complete the longer the time allowed for the reaction.

(3) Concentration of reacting substances both disinfectant and bacterial protoplasm.

. . . This is a mass action reaction, that is, the more concentrated the reacting substances, the greater the product which in this case is killed bacterial protoplasm.

. . . Dr. Chick—J. Hygiene, 8: 92(1908)—proposed that the reaction is of a first order type, expressed by this equation:

$$K = \frac{1}{t_2 - t_1} \log \frac{n_1}{n_2}$$

where n = the number of bacteria surviving at anytime.
t = time

. . . Thus the rate of death is proportional to the number of cells living at any given time, and the death curve has the familiar form of the law of diminishing returns when per cent killed is plotted against time.

(4) Extraneous matter, particularly of a colloidal and organic nature, generally interferes with the disinfection reaction, partly due to its own affinity for the disinfectant.

(5) Surface tension has an effect on the activity of a disinfectant; when the surface tension is lowered the rate of disinfection is increased.

(6) Other factors which affect disinfection are the nature of the disinfectant, pH, age of cells, spores, and the resistivity of the individual species to the disinfectant.

NEXT LECTURE—Disinfection—Part 2

(Front Row from Left)
Clarence R. Henry, Chief Chemist, Dept. of Water & Sewers, Miami; Eleanor A. Flanigan, Technician, Water Dept., West Palm Beach; David B. Lee, Director, Bureau of San. Eng., Florida State Board of Health, Jacksonville; R. E. Simon Supt., Orlando Sewage Treatment Plant; Thomas Paul, Chemist & Chief Operator, Water Treatment Plant, Bradenton.

(Rear Row from Left)
John B. Sellers, Supt. Water Treatment, City of Vero Beach; Eldon L. Holoubek, Water Plant Operator, U. S. Sugar Corp., Clewiston; D. Joe Raye, Supt., Clearwater Sewage Treatment Plant; C. M. Courson*, Supt., Tampa Sewage Treatment Plant; G. E. Cook, Chief Operator, Panama City Sewage Treatment Plant; S. P. Robinson, Supt., Lake Wales Sewage Treatment Plant; J. S. Whitney, Supt., Community Utilities, Miami; W. H. Case, Supt., Winter Haven Sewage Treatment Plant.

(*President, Florida Water & Sewage Works Operators Assn.)

Florida Plant Operators Cited by Dept. of Health

The Florida State Board of Health has cited 13 of Florida's more than 500 water and sewage plants for outstanding operation during the past year.

David B. Lee, Director of the Bureau of Sanitary Engineering, Florida State Board of Health, presented awards to the state's top operators at a banquet in Gainsville, Florida, during the 24th annual Water Supply and Sewerage Short School and Conference.

Heading the list of award winners were:

Jack Whitney, superintendent of the Community Utilities Corporation, of the West Coral Way area, a subdivision near Miami, water plant award for "the best primary treatment plant under 10,000 population" and sewage plant award for "the best activated sludge plant under 10,000 population." The Community Utilities Corporation was the only double winner.

Thomas Paul, superintendent of the Bradenton Water Works, water plant award for "the best filtration plant 10,000-25,000 population." This is the fifth year in which Superintendent Paul has received the top citation in his category.

Eleanor A Flanigan, chemist-technician for the West Palm Beach Water Works water plant award for "the best filtration plant over 25,000 population." Miss Flanigan is the first woman to receive a Board of Health award.

Other water plant winners included Eldon L. Holoubek of the United States Sugar Corporation Plant serving Clewiston, "the best filtration plant under 10,000 population"; John B. Sellers, of the Vero Beach Water Works, "the best lime-soda ash softening plant under 10,000 population"; Clarence Henry, Miami Water Department Chief Chemist, and W. L. Black, Hialeah Water Plant Superintendent, joint award winners for "the best lime-soda ash softening plant over 25,000 population."

Sewage plant award winners included Robert E. Simon, Orlando Sewage Plant, "the best overall operation"; George Cook, Panama City Sewage Plant, "the best trickling filter plant over 10,000 population"; Sam Robinson, Lake Wales Sewage Plant, "the best trickling filter plant under 10,000 population"; D. Joe Raye, Skycrest Plant, Clearwater, "the best activated sludge plant over 10,000 population"; Cliff Courson, Tampa Sewage Plant, "the best primary plant over 10,000 population"; and Bill Case, Winter Haven Sewage Plant, "the best primary plant under 10,000 population."

FSIWA Technical Program

29th Annual Meeting—Los Angeles, Calif., Oct. 7-11

THE FEDERATION of Sewage & Industrial Wastes Assns. will hold its 29th Annual Meeting at the Statler Hotel in Los Angeles, Calif. on Sunday to Thursday, Oct. 7-11, 1956. Registration will begin on Sunday, Oct. 7, on which day the Federation Board will hold its regular meeting. Because of the inspection trip to Hyperion Treatment Plant on Tuesday afternoon, there will be no Annual Federation Luncheon.

The program, as released Aug. 1, is as follows: it is subject to minor adjustments in final form.

Sunday—October 7

Registration
Board Meeting
Inspection of Exhibits

Monday—October 8

Morning

Address of Welcome
Secretary's Report
Activities of State Water Pollution Control Board of Calif. ..... *A. M. Rawn*

Afternoon

Atomic Energy Plant—Control of Stream Pollution ..... *R. Rostenbach*
Design and Operational Data on Sewage Treatment by Raw Sewage Lagoons ..... *Robt. Merz*
Discussion ..... *W. W. Towne*
Evaluation of Preaeration, Aeration and Sedimentation Processes at Hyperion Plant .. *R. D. Bargman*
Discussion ..... *Jack Pratt*
Tonnage Oxygen for Activated Sludge ..... *W. E. Budd*
Discussion ..... *Dan A. Okun*

Evening

Family Night

Tuesday—October 9

Morning

Operating Experiences with Activated Sludge—Biosorption at Austin, Tex. .... *A. H. Ulrich & Manzel Smith*
Super-Rate Biological Filtration ..... *Marvin Ray*
Oceanographic Studies at Hyperion Outfall .... *R. E. Stevenson*
Proposed Alterations to Hyperion Plant and Outfall ..... *R. J. Theroux*

Afternoon

Inspection Trip—Hyperion Plant

Wednesday—October 10

Morning

SESSION A

Laboratory Scientists Breakfast ..... *G. Channin, Leader; B. Martin; J. Crafts*

SESSION B

Sewer Maintenance Breakfast ..... *A. A. Appel, Leader*

SESSION C

Sewer Maintenance Forum ..... *A. A. Appel, Leader*

SESSION D

Operation of Oklahoma City Sewage Treatment Plants ..... *G. L. Morris*
California Fruit and Vegetable Cannery Waste Disposal Practices ..... *W. J. O'Connell*
Disposal of Dairy Wastes by Spray Irrigation ..... *Frank McKee*
Location of Wood Products Industries in Relation to Best Use of Available Natural Waters ..... *T. Arvolo & V. Bacon*

Afternoon

SYMPOSIUM A—Governmental Agencies ..... *Milton P. Adams, Leader*
Problems of State Water Pollution Control Programs ..... *A. F. Dappert; D. Smallhorst; M. D. Hollis*

SYMPOSIUM B—Research ..... *Jack McKee, Leader*
The Sanitary Engineering Research Grants Program—A Progress Report ..... *H. A. Faber*
Algae in Waste Treatment ..... *W. J. Oswald, H. B. Gotaas, W. Keller & C. G. Goluche*

Discussion ..... *E. Gloyna*
Experimental Vertical Screen Trickling Filter ..... *K. L. Schulze*
Anaerobic Contact Processes for Sewage Disposal .. *J. B. Coulter, M. B. Ettinger & S. Soneda*

Evening

Awards' Dinner and Dance

Thursday—October 11

Morning

SESSION A

Industrial Wastes Forum ..... *E. F. Eldridge, Leader*

SESSION B

Operators Forum ..... *W. F. Garber, Leader*
The Engineer as a Manager ..... *E. P. Coleman*
Public Health Service Programs ..... *B. B. Berger*
Maintenance of Flow Meters and Instruments ..... *J. M. Betz*

Afternoon

Board Meeting

Jackson of "P. D. M." Honored by Alma Mater

James O. Jackson, vice-president in charge of engineering for Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa., has been named engineer of the year by his alma-mater.

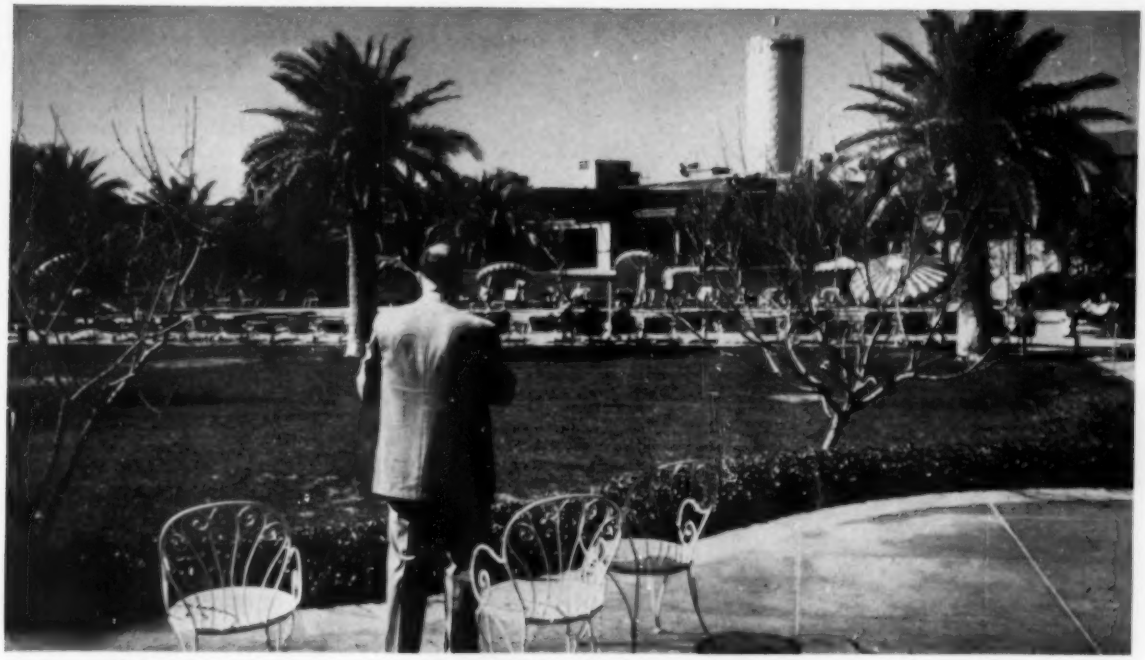
Iowa State College chose Mr. Jackson (C. E. 1917) as recipient of its Marston Medal which is voted to its outstanding engineering graduates.

Mr. Jackson who joined Pittsburgh-Des Moines Steel Co. upon graduation in 1917 has for the past 30 years had charge of all engineering activities of the company, involving original design of steel stand-pipes, elevated tanks, spherical liquid and gas storage tanks, bridges and buildings.

Ferric Chloride Stops Hydrogen Sulphide Liberation

A recent use of ferric chloride is its application to stale or septic sewage for rendering hydrogen sulphide non-volatile.

The purpose of adding the iron salt was to "fix" the volatile sulphide, gas, as it is produced, by converting it into non-volatile sulphides of iron. It is reported to have stopped white painted houses from turning grey or black, due to the formation of lead sulphide from the white lead in the paint. In correcting this condition, the ferric chloride treatment also corrected a serious odor nuisance created by liberation of hydrogen sulphide gas.



RECREATIONAL area irrigated with reclaimed sewage—Flamingo Hotel, Las Vegas, Nev.

Direct Utilization of Waste Waters*

by ROBERT C. MERZ

Mr. Merz is Professor of Civil Engineering at the University of Southern California in Los Angeles, Calif. In this paper presented at the 11th Purdue Industrial Waste Conference, he summarizes the results of an engineering study made under his direction.

THE IMPETUS for much of the early use of waste water has, in many cases, been born of necessity. Engineering ingenuity has brought about many present-day practical demonstrations of the successful utilization of waste waters. As information regarding these practical demonstrations becomes better available, the re-use of waste waters is certain to be accelerated.

It was our good fortune to be selected by the California State Water Pollution Control Board to investigate and report on current practice. To locate water reclamation projects of interest and importance, a survey of state agencies was made. The information provided by the survey formed the basis for selection of key projects to be personally visited. It was soon apparent that all projects visited would fit into one of the following four classifications: industrial use, agricultural use, recreational use, or ground water injection.

*Published by permission of the Conference.

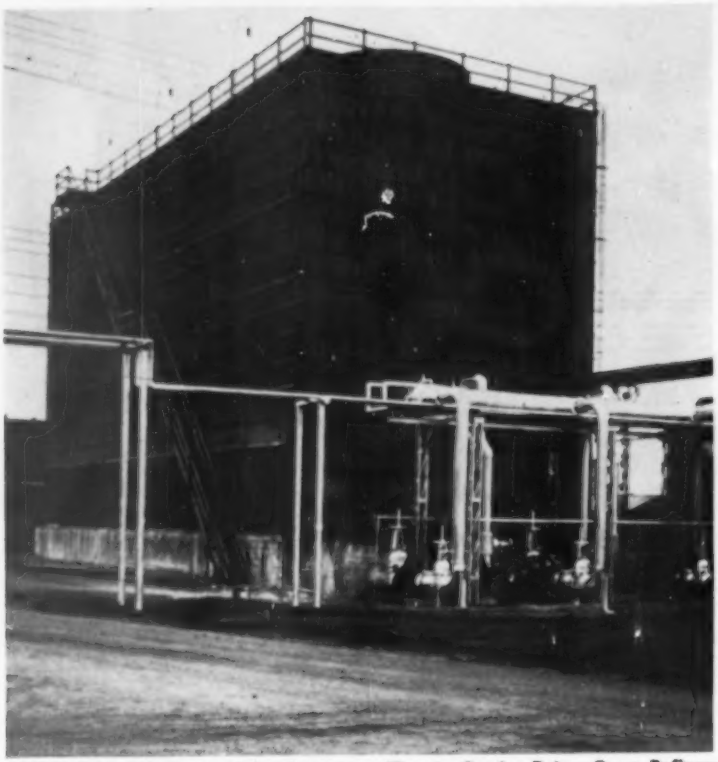
Direct Utilization of Waste Water by Industry

Mining, metallurgical and allied industries, located in the arid regions of the United States, have pioneered in the reclamation of waste waters because insufficient supplies of conventional surface and ground waters have dictated the re-use of available waste sewage and industrial effluents. Today, an added incentive for reclaiming waste waters is the necessity to comply with State and Federal stream and ground water pollution control regulations.

As a result of the growth of engineering knowledge and the successful experiences obtained at older installations, planned water reclamation need no longer be considered a novelty. Many large industrial plants find that it is desirable to re-use low cost effluents because there are significant savings.

A tabulation summarizing the present utilization of industrial waste waters and sewage effluents shows that there are more than 150 industries located in 38 of our States reported to reclaim industrial wastes; and about 15 industries in 9 States reported to employ sewage effluent.

The re-cycling of wash water by



COOLING tower using reclaimed sewage effluent—Cosden Petro. Corp. Refinery, Big Springs, Tex.

the coal industry is almost standard practice. In Kentucky alone, over 75 collieries use re-cycled waste water from settling ponds for coal washing operations. There are some nine copper ore plants in Arizona that re-cycle tailing pond water. The Florida phosphate hydraulic mining industry conserves wash water by utilizing settling basins. In order to prevent contamination of the Florida streams, and the destruction of fish life, this wash water is constantly re-cycled, and thereby stream pollution is minimized. An example of the large quantity of water thus reclaimed is provided by the Davison Chemical Corp., at Bartow, Fla., where 25,000 gpm are employed over a 16-hour operating day. Other hydraulic mining operations that re-cycle settled waste water are commonplace in the industry.

Waste water is successfully reclaimed at many industrial sites for cooling water and process makeup as well as for irrigation of grounds, recharge, fire protection systems and even boiler feed makeup. Particular examples of such use are: The Kennecott Copper Co. installation at Hurley, N. Mex., which reclaims all available waste water including septic tank effluent from 3 small towns. The waste water is introduced into ore concentration units and lime is added to the mixture as an aid in the separation process. The lime also serves to produce a high pH water which improves the sanitary quality of the process waters.

The limited available ground and surface waters are conserved for the potable supply and for cooling tower and boiler feed makeup. The blowdown from all mill operations together with surface drainage is collected in a tailings pond and is then re-cycled back into the plant processes.

Reclaimed Sewage Effluents for Cooling Water

Reclaimed sewage effluents are normally suitable for cooling tower makeup. For example, at the Los Alamos, New Mex., Scientific Laboratory of the Atomic Energy Commission, chlorinated standard rate trickling filter effluent provides low cost makeup water for the cooling tower system of a large, modern, steam power plant. Here is a sound example of planned reclamation. The cost of pumping water from the low elevation where the water wells are located to the high point where Los Alamos exists on an elevated plateau makes waste water economically desirable.

The conservation of the limited available water resources was also important to the downstream water users. Algal growths in the cooling towers are controlled by means of shock dosages of chlorine. Careful tests performed by Los Alamos engineers indicate that there is excellent wood preservation in the cooling towers. Studies of heat exchanger scale deposits demonstrated that the small quantities of organic matter and nitrogen present in the effluent enable the boiler tubes to be cleaned more easily because of the formation of a soft scale. The heat transfer rates have been as good as those reported with conventional waters. The corrosion in the cooling system appears to have been reduced. No significant odor or other nuisances have developed.

At the American Potash and Chemical Co. plant, Trona, Calif., a highly mineralized water is utilized for cooling purposes. The cooling tower normally recirculates 75,000 gpm of water containing 3,500 ppm total dissolved solids. This cooling tower water is treated with an organic compound and then bromine is added for algae control. The brackish water is also employed for the irrigation of tamarisk trees. Certain local waters are high in potash and other mineral content and the chemical works, in order to obtain a suitable low mineral content water for boiler feed, evaporates the brines and uses the condensate for boiler feed makeup. The concentrate supplies the various chemicals produced by the processing plant.

The Cosden Refinery at Big Spring, Texas, is a 20,000 barrel a day plant that processes an extensive line of petroleum products. The entire process water requirements including boiler feed makeup is supplied by activated sludge type effluent sold by the City of Big Spring. An average of 1.2 mgd is purchased by the refinery at a cost of five cents per 1000 gallons for the first million gallons used each month, and for additional quantities four cents per 1000 gallons is charged. Since 1944, the effluent has been used at the refinery after softening the waste water in a conventional hot lime-phosphate treatment plant. A defoaming agent is added to the boiler feed makeup water. The cooling water system and all other plant process waters are derived from this effluent supply. There are no significant operation difficulties or asthetic nuisances reported.

The City of Amarillo, Texas, has a similar sales contract with a local

refinery to provide as much as 4.5 mgd of the effluent from its activated sludge plant for cooling tower make-up and other uses. The refinery has obligated itself to pay for the total cost of construction and operation of the 4.5 mgd treatment plant, plus a minimum of 3.57 cents per 1000 gallons of effluent utilized. This is a fine example of conservation of available water resources for higher use, and particularly so when it is considered that at present there is no water shortage in that area.

There are many other examples of the use of reclaimed waste water in industry, either by re-use of sewage effluents or re-cycling of a plant-produced waste. One of the most interesting of such plants is located near Provo, Utah. There, the Columbia-Geneva Steel Division of the United States Steel Corp. operates a very large smelter and other steel processing works. The works has been operating since 1942. A study by the United States Geological Survey, reported in its Professional Paper 257a, carried the following statement. "It must be concluded . . . that the Geneva Steel Plant, even with its enormous use of water, does not deplete the net available supply as much as did the same property under an agricultural economy." The Fontana Steel Plant at Fontana, Calif., operated by the Kaiser Steel Company, is another example of a large steel manufacturing works wherein a sound water conservation policy has enabled the reclamation of a waste water.

Agricultural Use of Waste Waters

Turning now to the agricultural use of waste waters, we find that land disposal is still practiced in many areas of low annual rainfall and in most of these locations the results are economical. Let me remind you again, that these comments refer particularly to western practice. No attempt is made in this paper to review spray irrigation methods for disposal of canning plant wastes, or other methods familiar to persons in the midwest or the east. In the light of present day knowledge, the use of domestic sewage effluents for agricultural purposes can benefit a community by providing (1) a safe and satisfactory disposal for waters that might otherwise cause stream pollution, (2) a conservation of other waters for more beneficial or higher value uses and (3) agricultural nutrients for the land.

Sewage farming is a term which applies specifically to the agricultural utilization of a sewage. Today, sewage farms are, in most cases, agricultural enterprises that utilize a treated or partially treated sewage effluent for the produtcion of crops and raising of animals. In the process, they provide a degree of secondary treatment in addition to disposing of the water. At Fresno, Calif., the city sewage farm utilizes the effluent from a primary treatment plant for production of crops and beef. The farm takes the place of secondary treatment that would be needed to provide a satisfactory effluent for disposal to a canal or stream. In addition, a degree of treatment is provided for the portion of water that recharges the ground waters by its filtration through the soil.

The operation of the sewage farm as a strict agricultural enterprise suffers from this arrangement as it is necessary to maintain a certain portion of the farm in readiness for the extra loading that becomes necessary during high flows and wet weathers. Water additions to valuable marketable crops must be in accordance with their growth needs and hence the portion of land that can be so utilized has to be reduced. Arrangements have sometimes been made with adjoining land holders to help in the disposal of extra waters occurring in flood time.

In the dry desert areas, the agricultural utilization of effleunts becomes a distinctly separate farming operation in which the effluent is used in lieu of another irrigation water, an important limitation being the local requirements regarding the type of crops that can be raised.

Topography, Soil Conditions and Climate are Important

The utilization of waste water for agricultural purposes is dependent on two primary factors. These factors are land and climate.

In the United States, these factors have limited the practice of sewage effluent irrigation to the semi-arid acres of the west. Industrial waste waters are being satisfactorily disposed of by irrigation, however, in all parts of this country. Some experiments have been made regarding use of sewage effluents in a humid area with annual rainfall of 30 in. or greater. Other conditions that indicate a land to be suitable for irrigation with a waste water are topography, and soil type. In general, on land where conventional irrigation is practiced using other surface or ground waters, irrigation with sewage effluents and waste waters can also be accomplished. However, the requirements for continuous application and disposal of waste water to land, and the restrictions on the type of crops to be grown, may make operation less profitable than irrigation with available, low cost natural water. In areas where crops are limited by soil type and where location is suitable to crops that are adaptable to irrigation with effluent, the yield per acre for land using sewage effluent often exceeds that for other lands because of nutrients in the sewage water.

RESERVOIR of reclaimed sewage effluent for irrigation system—Diamond Bar Ranch, Pomona, Calif.

Topography is an important factor for irrigation with waste waters. With new methods such as spray irrigation, waste waters are now being sprayed on rather steep hillsides and in rather heavily wooded areas at extremely high rates. At Seabrook Farms in Bridgeton, N. J., waste waters from vegetable processing have been disposed of to a 180 acre tract of woodland containing 300 to 400 oak trees per acre, and a ground cover of dogwood, blueberry and mountain laurel. Overhead sprinklers are used to spray the waste water at a rate of 350 gpm over an area of one acre each. No soil clogging has occurred with loadings of over 200 lb of B.O.D. per day and a sodium content of approximately 425 ppm. in the sandy loam soil.

There are similar undertakings at some of the California State Parks. Hillside spraying is practiced at the Calvaras Big Trees State Park. A settled sewage effluent from the public septic tank in the park is discharged through a header, and by

ORE CONCENTRATION unit utilizing effluent from septic tank in foreground—Kennecott Copper Corp., Hurley, N. Mex.

means of fixed sprays to a forrested hillside. Adequate disposal without runoff, odors, or erosion has resulted, and this system appears to be quite feasible.

Soil conditions can cause an extreme variation in spreading or irrigation rates, but a review of places practicing irrigation with sewage effluent shows many soil types being used, at rates varying from 12 to 208 in. per yr. At the Ontario, California, sewage farm, where a sandy soil allows high percolation rates, 195 in. per yr. are applied. Low rates occur in clay soils where little if any percolation occurs, but in both cases successful farming with irrigation can be practiced.

Climate is rather obviously related to the land disposal of sewage effluents and waste waters. In the semiarid areas with long growing seasons, water demands for growing crops may reach 8 ft per yr. The greater portion of California uses 3 to 5 ft of water in a year. The problem of disposal of waste water on land is complicated by climatic factors such as annual rainfall, seasonal runoff, evaporation and growing season. These can limit the location where irrigation with waste water can be used.

Land Preparation and Sewage Pretreatment

American practice in land preparation is typified at Bakersfield and Fresno, Calif., where deep plowing is employed to break up the plow pan and increase the permeability of the soil. Where land is being reclaimed from desert it must be leveled and provided with a waste water distribution system either by laying pipes or ditching. Investments of as much as $100 per acre are made in preparing land for irrigation. Land preparation techniques are similar to methods used for conventional irrigation with the exception that particular care must be exercised to prevent ponding of sewage effluent that would give rise to nuisance conditions.

Pretreatment of sewage that is to be used for irrigation varies from crude sewage lagoons to secondary treatment including oxidation ponds. The advantages of no treatment are: (1) total fertilizer values are retained and (2) no treatment cost is added. The advantages of pretreatment are: (1) removal of settleable material eliminates many pathogenic organisms, seeds and unsightly material, (2) there is less material to form sludge deposits in distribution systems and fields, (3) flies, odors and other nuisances are controlled, and (4) pretreatment may make possible alternate methods of disposal.

Pretreatment of sewage by a secondary type treatment process offers the advantage of a high quality effluent suitable for alternate disposal to a stream, but the extra treatment is not desired by farmers if results at San Antonio, Texas, are an indication. Operators of the four largest farms using the effluent from this plant all expressed a preference for the digester supernatant over the final effluent or green waters from Mitchell Lake. Farmers that have irrigated for a long period of time stated a preference for a liquid which they believed gave them the most fertilizing value. This area has been irrigated with San Antonio sewage for over 50 years.

Pre-irrigation is desirable with wastes that are toxic to growing plants. The Exchange Orange Products Co. Farm in Ontario, Calif., disposes of 1000 ppm B.O.D. waste, without damaging the soil, by pre-irrigation of the fields. About 60 acres of land are thus treated for a three to four month period, after which it is planted. The absorption rate of this sandy soil is much higher than the rate of application of about 0.5 in. per day, and the soil dries out within two days. Once the crop is planted, well water is used. Pre-irrigation with effluent or untreated sewage is permissible for vegetables that can be eaten raw. Further irrigation of the growing vegetables should be with high bacterial quality water.

The cities of Upland and Ontario, Calif., operate a sewage treatment plant on a farm where 3.5 mgd of secondary treated sewage effluent are disposed of by irrigation of 230 acres of land. The methods used on this farm include flooding, furrows and sprinkling, and the average yearly rate over the entire farm is about 200 in. per yr. Since the entire farm is cropped and pastured, an actual irrigation rate may be much greater than this. This farm has been in continuous use for 50 years.

Factors Restricting Crops That Can Be Grown

Crops that are grown by irrigation with sewage effluents are restricted by: (1) the amount of waste water to be disposed of, (2) the quality of the effluent, and (3) health regulations concerning use of sewage or sewage effluent on crops.

In California, irrigation with a sew-

age effluent may be currently witnessed at Bakersfield, where 6.5 mgd of primary effluent are being used for irrigation of pasturage, cotton, alfalfa, grasses and the pre-irrigation of potatoes; at Fresno, where 22 mgd of primary effluent are being used for irrigation of corn, grain, alfalfa and grasses grown for cattle feed; at Wasco, where primary effluent is used for the irrigation of alfalfa, corn and cotton; at Pomona, where activated sludge effluent is used for the irrigation of alfalfa, citrus, grain and grasses, and for the watering of cattle; at Tulare, where 1.9 mgd of filter plant effluent are used for the irrigation of alfalfa, grain, grasses, sunflowers and for the watering of cattle.

In Texas, irrigation with a sewage effluent may be witnessed currently at Abilene, where 5.0 mgd of raw sewage lagoon effluent are being used for irrigation of grain, grasses, and maize and for the watering of cattle; at Kingsville, where 1.0 mgd of raw sewage lagoon effluent is being used for the irrigation of alfalfa, corn, cotton, grain and grasses; at Lubbock, where 6.0 mgd of filter plant effluent are used for irrigation of barley, cotton, sorghum and wheat; and at San Antonio, where 23.0 mgd of activated sludge effluent are used for irrigation of alfalfa, corn and grasses and for the watering of cattle and horses.

The yields of crops irrigated with sewage effluents are usually stated to be the same or higher than crops grown with only the use of a native water. In dry areas, the yield of a crop is proportional to the amount of moisture used and to the fertilizer materials present. A ranch operator using San Antonio sewage effluent states that this ranch will support two cows per acre compared with one cow per 30 acres on local non-irrigated land.

This ratio of pasture of beef cattle on land irrigated with a sewage effluent points up the value of an effluent for a land lacking water supply. Grazing of beef cattle is one of the more widely used methods of utilizing the effluent waters. Grasses can take higher doses of effluent and can stand some ponding. The interval of time necessary to dry pastures so that they will not be cut up by the hoofs of the animals, aids in the dessication of harmful organisms.

Effect of Effluent Quality on Crops

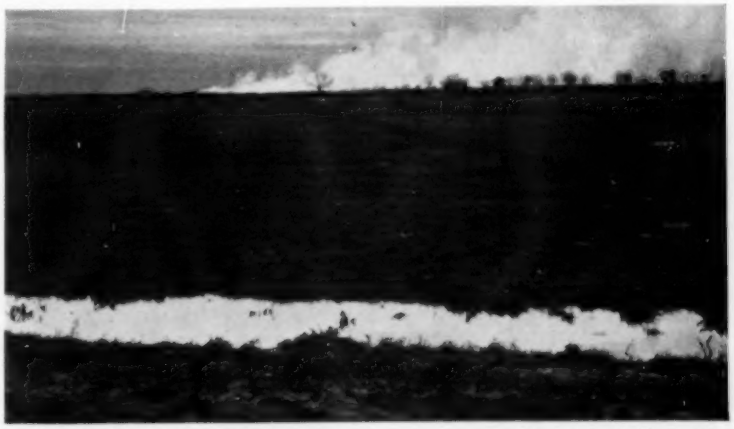
The second factor listed above restricting the crops grown by means of sewage irrigation was the quality of the effluent. Sewage effluents contain greater amounts of dissolved material than the original waters. The amounts of total solids dissolved in water, the amounts of chlorides and boron and the sodium ratio are of importance to agricultural users.

When water is used at rates higher than required by crop growth, increased percolation may carry dissolved solids to the ground water. This use of excess water is common practice to keep the concentration of salts in the soil at levels that are beneficial to plant growth. Desirable concentrations of total solids, of boron, and the sodium ratio for classes of water ranging from excellent to unsuitable as proposed by the U. S. Salinity Laboratory, have been widely quoted in the literature over the past seven years. Limits for a permissible, or mid-scale class of water, are: dissolved solids 525-1400 ppm, per cent sodium 40-60, boron 0.67-1.00 ppm for sensitive crops.

Mineral increment increases for one cycle of domestic water use have been shown to have a normal range of from 100 to 300 ppm total dissolved solids, 0.1 to 0.4 ppm boron and from 5 to 15 per cent sodium ratio. In some cases, a sewage effluent may be produced that would have mineral contents greater than the desirable limits for agricultural use. High boron concentrations have caused the greatest concern in citrus irrigation areas.

The third factor concerned health requirements. Health requirements for the use of sewage effluents vary in the several western states. In California, the use of raw sewage is not permitted and crops are restricted when irrigation is by settled or un-

HEAD WORKS for controlling discharge of stored sewage effluent—Lake Mitchell, San Antonio, Tex.



PASTURE LAND irrigated with effluent from raw sewage lagoons—Abilene, Tex.

GOLF COURSE irrigation system using sewage effluent—Jal, N. Mex.

disinfected sewage effluents. Further regulations are quoted as follows:

"Effluents of septic tanks, Imhoff tanks or of other settling tanks, or partially disinfected effluents or sprinkling filters or activated sludge plants or similar sewages, shall not be used to water any growing vegetables, garden truck, berries, or low growing fruits such that the fruit is in contact with the ground, or to water vineyards or orchard crops during seasons in which the windfall or fruit lie on the ground. Nursery stock, cotton, and such field crops as hay, grain, rice, alfalfa, sugar beets, fodder corn, cowbeets, and fodder carrots may be watered with such settled or undisinfected sewage effluents provided that no milch cows are pastured on the land while it is moist with sewage, or have access to ditches carrying such sewage. However, such sewage may be used for irrigating growing vegetables grown exclusively for seed purposes in fields where crops are raised and watered not in conflict with this rule."

Properly disinfected, treated sewage meeting bacterial standards equivalent to drinking water standards may be used for all crops. Other states in the west operate with similar regulations; and some do not use formal regulations. In general, restrictions are designed to prevent the transmission of disease through handling and consumption of food. These requirements generally serve to limit the operation of a farm using primary sewage effluents to the growing of forage and specialized crops. Agreement exists regarding the prohibition of pasturing milch cows and beef cattle. Most western states allow the pasturing of dry cows or beef cattle and in many places actual consumption of the effluent by the cattle is common.

Costs of Irrigation With Reclaimed Effluents

The cost of irrigating a farm with reclaimed effluents is perhaps greater than for a farm which utilizes conventional water. The reason for this is the necessity for handling large quantities of water even during wet periods. It may even be necessary to store or bypass the effluent waters when they are not required for irrigation of crops. In addition, some sanitary control such as protection of personnel against disease transmission, the control of mosquitos, and the prevention of flies and odor conditions may require the expenditure of additional monies.

On the other hand, the availability of irrigation waters in arid regions, in many cases makes it possible for the disposal of wastes at nominal costs. There are locations where farmers contract with the waste-producing community for the right to receive and employ waste waters for irrigation. These farms pay the municipality so that there is actually a profit as a result of such irrigation practice. In California, private farmers are paying in the neighborhood of $6 per acre foot for effluent, or leasing land for about $10 per acre per year with the additional requirement that all effluent must be accepted. Some municipalities operate their sewage farms on a share-crop basis with returns as high as $25 per acre per year.

Reclamation for Recreational Use

The third class of reclamation enumerated above was recreational use. Traditionally, one of the outstanding examples of a waste water reclamation plant has been the installation located at Golden Gate Park in San Francisco. The activated sludge plant there is providing an effluent which is chlorinated and used for maintaining the level of decorative lakes and the irrigation of pastures, grass and gardens. Some of the swank hotels at Las Vegas treat and use their own effluents for irrigation of their grounds.

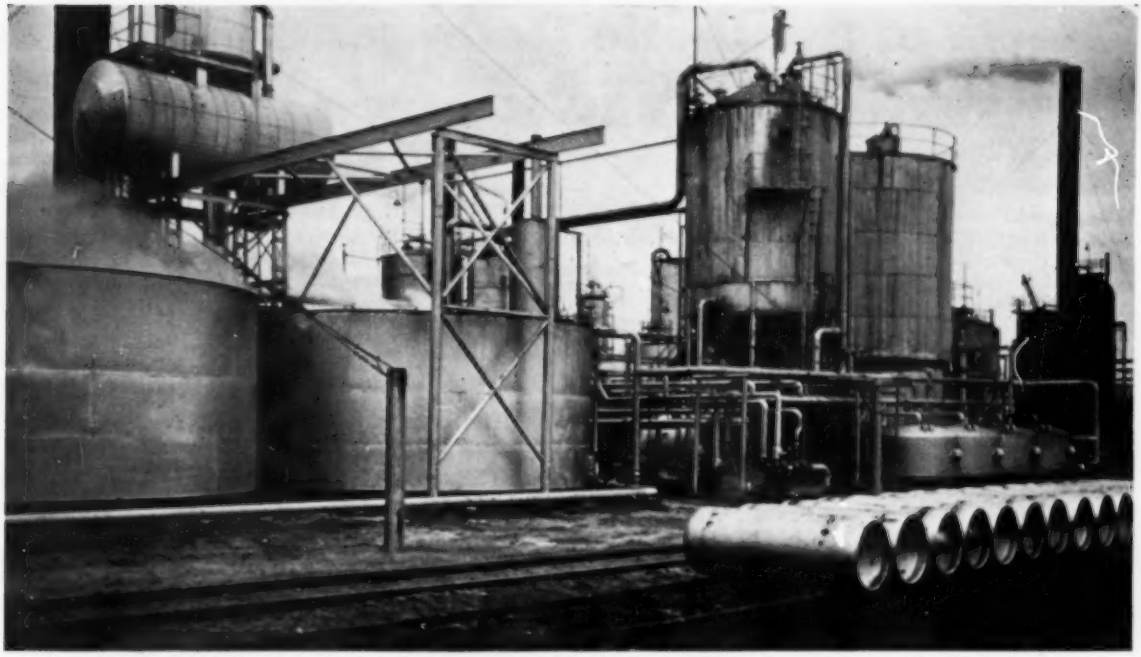
In recent years, an extensive use of reclaimed effluents for irrigation of golf courses has developed. The Marine Bases at El Toro and Pendleton, Calif., are examples of locations where golf courses have been irrigated successfully with sewage effluents. At El Cajon, and near Palo Alto, Calif., there are semi-public courses which are now under construction and which will utilize sewage effluent for irrigation.

The operators of golf courses surveyed in other locations such as Los Alamos, New Mex., Carlsbad and Jal, New Mex., and the Desert Inn, Las Vegas, Nev., concur that the utilization of normal sewage effluents is satisfactory for this purpose. It is indicated that high salinity soils, or soils with high clay content, may incur difficulties with certain salt sensitive grasses. However, in general, it has been shown that golf courses, employing sewage effluents, are able to maintain themselves without additional fertilization. Also, these courses are able to establish satisfactory grass growths in about one-half of the normal period of time, i.e., anywhere from one-half to one year rather than one to two years. At El Cajon, Bermuda grass roots to a depth of 14 inches developed in six months.

It is estimated that the average quantity of sewage effluent being applied to land in California for purposes enumerated above is at least 50,000 acre-feet per year, and we see no reason why, with suitable planning and proper respect for basic fundamentals, the practice could not be greatly expanded. It is believed that the future application of reclaimed sewage for irrigation of parks and, particularly, for golf courses hold considerable promise.

Ground Water Replenishment

The fourth and final classification to be mentioned briefly is that of



HOT PROCESS treatment for reclaiming sewage effluent—Cosden Petro. Corp. Refinery, Big Springs, Tex.

ground water injection. The use of waste water for this purpose is a developing application in the field of waste water reclamation.

The Los Angeles County Flood Control District in the past has conducted tests at Whittier, Calif., in 1948, and at Azusa, Calif., in 1948-49 to determine the effects of spreading sewage and recharging underground water supplies. At present the Azusa trickling filter plant is operated at a flow rate of 0.5 mgd and continues, as it has over the past 12 years, to spread and recharge effluent to the underground basin. There are a great many other sewage treatment plants in California which recharge underground waters incidental to normal plant operation.

Today, the Los Angeles County Flood Control District is studying the feasibility of employing effluent from the City of Los Angeles' Hyperion Plant for spreading and admittance into a controlled aquifier from which the percolated water will be pumped and utilized for recharge at the Manhattan Beach demonstration site for maintaining a fresh water barrier against ocean water intrusion.

The recharge of ground water by effluent is an incidental, unplanned occurrence in numerous locations throughout the United States. The planned reclamation of waste waters for recharging underground basins undoubtedly will be practiced on a more scientific basis as a result of developing knowledge in this field.

The petroleum industry has been a leader in the development of reutilization of its own industrial waste. Oil field flooding, using brine wastes, is carried on in several states. In California, approximately 96 billion gallons have been disposed of to date in this way at a cost of about $148 per mg. Here, and in other oil producing states, the re-pressurizing of oil strata is proving to be the most important method of developing additional oil yields and at the same time protecting surface and ground waters against pollution.

As industrial, agricultural and recreational water requirements increase, and the supplying of adequate amounts of fresh water entails the importation of water from distant areas, the value and feasibility of reclaiming existing waste water supplies becomes more evident. The use of sewage effluents will be better accomplished only when the experience and record of prior practical application is available for guidance. The investigations made thus far indicate strongly that the reclamation of sewage effluents is a sound practice for industry, agriculture, and other uses.

U. S. P. H. S. Offers Traineeships to Sanitary Engrs. & Chemists

Traineeship awards of from $3,000 to $4,800 per year are available through the U. S. Public Health Service to sanitary engineers, cnemists, biologists and sanitarions interested in graduate or special public health training.

In addition to the base awards to accepted trainees, an allowance of $360 per year per dependent is available where the trainee has legal dependents. In addition there is a travel cost re-imbursement of the rate of 6 cents per mile travelled to the point where the training is given. Tuition costs are paid in addition to the awards which follow.

Degree Held by Trainee	*Annual Stipend*
Ph. D.	$4,800
M.S.	$3,600
B.S.	$3,000
Less than above	$2,400

The trainee can choose any one of eleven accredited universities, with Schools of Public Health, at which to take these post-graduate courses. To begin with the 1956-1957 term quick action is necessary. For a list of these universities and application blanks, apply to any regional office of The Public Health Service or to The Division of Sanitary Engineering Services, U.S.P.H. Service, Washington (25) D. C.

Effects of Synthetic Detergents on Activated Sludge*

by R. M. MANGANELLI, Ph. D.
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THE ACTIVATED sludge process is a complex physical, chemical, and biological phenomenon which effects a high degree of removal of pollutional material from liquids by the utilization of biological communities in the presence of sufficient oxygen.

This process can be divided, generally, into two phases: clarification and oxidation. Clarification is ascribed to a physical process in which removal of colloidal and suspended material by active floc occurs within relatively short time—30 to 60 minutes. The oxidation phase involves the consumption of food in presence of oxygen for energy production and cell synthesis. During this stage there is a change in the structure and composition of pollutional matter.

These phases are controlled by the interplay of three general factors—food, organisms, and environmental conditions. Presence of certain specific chemical compounds in the substrate may influence the balance and relationship of these factors. Such compounds are synthetic detergents whose increasing sales indicate a widespread distribution and higher concentration in waste waters.

This paper serves as an approach to the fundamental mechanisms of the action of synthetic detergents on a complex biological community of activated sludge and its activities.

In these laboratory investigations, representatives of the three main types of surface active agents were employed, namely; Nacconol N.R. (anionic), Tween 80 (nonionic) and Ceepryn (cationic). These compounds were added in quantities expected in sewage and certain industrial wastes. The concentrations ranged generally up to 100 ppm based on the active matter present.

The oxygen utilization studies were carried out by means of a Warburg Respirometer at 20 deg. C.

Effect on Activated Sludge Oxidation at Various pH Levels

A series of experiments were conducted to determine the effect of anionic, cationic, and nonionic detergents at various pH values on (a) the oxidation of sewage by activated sludge organisms and (b) the oxygen uptake of sludge itself.

Washed activated sludge was adjusted to pH of 5, 7 and 9 by buffers and diluted with detergent free sewage (previously adjusted to proper pH) so that the final solids concentration in the mixed liquor was 1000 ppm. Included in the mixed liquor were various quantities of anionic Nacconol, cationic Ceepryn and nonionic Tween 80, ranging up to 100 ppm.

Some of the results obtained for the control and for the samples containing 100 ppm of the anionic and cationic detergents with and without sewage are summarized in Table 1.

It is evident that during the oxidation of sewage by activated sludge in the presence of Nacconol N. R., the decrease in oxygen utilization was greatest at pH 5. In the presence of cationic Ceepryn, the decrease in oxygen utilization was greatest at pH 9. The oxygen uptake of the sludge alone in the presence of Nacconol showed an increase over that of the control at all pH levels while Ceepyrn caused a decrease in oxygen uptake of sludge alone. This decrease was greatest at pH 9.0. Similar trends were observed for the lower concentration of these detergents. Nonionic Tween 80 was oxidizable and displayed no adverse effect on the oxidation of sewage or oxygen uptake of activated sludge at the various pH levels.

As the pH of activated sludge becomes relatively more alkaline with respect to its isoelectric point (pH 4.0-4.6), the overall negative charge increases. Conversely, a decrease in pH to the isoelectric point causes an increase in positively charged sites and a decrease in the overall negative charge on the sludge. Thus cationic Ceepyrn—possessing a positive charge in solution—reacts more rapidly and extensively with the sludge as the pH becomes more alkaline, while negatively charged Nacconol reacts more strongly with the sludge as the number of positively charged sites increase; that is, as the pH becomes more acid.

Reaction of detergent with the activated sludge interferes with oxidation of sewage. Nacconol, in the presence of sludge alone, produces a stimulatory effect on the endogenous respiration of the sludge. Tween 80, having no dissociable groups, does not interact ionically and being oxidizable, is readily removed from the mixture.

Effect on Oxidation at Various Sludge Solids Concentrations

Activated sludge, washed and buffered to pH 7.0 was diluted to final concentrations of 500, 1000, 2000 and 4000 ppm solids with the mixed li-

* Paper of the Journal Series, N. J. Agr. Expt. Sta., Rutgers Univ., the State Univ. of New Jersey, Department of Sanitation, New Brunswick, N. J. Presented at the 11th Annual Purdue University Industrial Waste Conference. Published here by permission.

TABLE 1

Effect of 100 ppm of Nacconol N.R. and Ceepryn on Oxygen Utilization of Activated Sludge in Presence and Absence of Sewage at Various pH Levels

	Oxygen Utilization in % of Control							
	Nacconol N.R.				Ceepryn			
	Sludge Alone		Sludge + Sewage		Sludge Alone		Sludge + Sewage	
pH	6 hr	24 hr	6 hr	24 hr	6 hr	24 hr	6 hr	24 hr
5	100	132	71.0	88.5	45.0	75.0	62.3	76.5
7	157	195	81.5	101	53.8	72.0	41.5	69.5
9	95	134	78.0	96.0	39.6	27.7	32.7	66.0

quor containing 100 ppm of Nacconol N.R. or Ceepryn.

The effects of Nacconol and Ceepryn on the oxygen utilization of the sludge alone and sludge plus sewage are shown in Table 2 for 6 and 22.5 hour periods. It may be seen that the presence of 100 ppm Nacconol produced a stimulatory action on oxygen uptake of activated sludge alone for all the mixed liquor concentrations employed. For 1000 ppm mixed liquor concentration, the stimulatory effect of Nacconol persists up to approximately 200 ppm of the detergent. Above this level oxygen uptake is inhibited (Table 3). However, Ceepryn caused a decrease in oxygen uptake of sludge alone for lower mixed liquor concentrations. This inhibiting effect gradually turned to a stimulatory one as the concentration of sludge solids was increased.

During the oxidation of sewage, Nacconol caused a suppression of oxygen utilization when 500 ppm solids in mixed liquor was employed. With 1000 and 2000 ppm solids in mixed liquor, Nacconol had an adverse effect for the first 12 hours. In the presence of 4000 ppm solids, an increase in oxygen utilization throughout the oxidation period was observed.

Cationic Ceepryn exerted a suppressive action on oxygen utilization for activated sludge mixed liquor concentrations up to 2000 ppm. With 4000 ppm activated sludge solids, the inhibiting effect of Ceepryn was overcome after approximately 12 hours contact.

In these experiments, anionic Nacconol was found to cause stimulation of endogenous respiration of the activated sludge in all the ratios of detergent to activated sludge solids employed; namely, 1:5 (100 ppm Nacconol and 500 ppm solids) to 1:40 (100 ppm Nacconal to 4000 ppm solids). This indicates that the ratio of 1:5 detergent to solids was still not sufficient to inhibit endogenous respiration with one passage. In the case of sewage oxidation by activated sludge, inhibition of oxidation took place. This action was overcome as the activated sludge solids increased (decreasing ratio of detergent to solids) and reverted to a stimulatory action.

The adverse effect may be due to interference with adsorption of the nutrients by the sludge flocs and subsequent possible interference with the catabolic processes of the organisms. As the sludge solids concentration increased, the surface of the sludge and the number of organisms increased, consequently reducing the effective

TABLE 2

Difference in Oxygen Utilization Between Control and Samples Detergent Containing Calculated on 1000 ppm Solids Basis

Orig. Solids Conc. ppm	Oxygen Utilization* ppm							
	100 ppm Nacconol N.R.				100 ppm Ceepryn			
	Sludge Alone		Sludge + Sewage		Sludge Alone		Sludge + Sewage	
	6 hr.	22.5 hr.	6 hr.	22.5 hr.	6 hr.	22.5 hr.	6 hr.	22.5 hr.
500	+8	+56	−46	−38	−36	−82	−92	−122
1000	−4	+40	−12	+56	−24	−26	−44	−47
2000	+9	+62	−14	+4	−7	+3	−25	−34
4000	+11	+49	+5	+59	+4	+14	−7	+8

* Oxygen utilization of sample minus oxygen utilization of control

level of Nacconol. When the sludge solids were sufficiently high (4000 ppm), adsorption and oxidation of the food matter took place readily and stimulation of bacterial metabolism—or, more logically—stimulation of respiration occurred as shown by an increase in oxygen uptake.

With cationic Ceepryn, inhibition of oxygen uptake activated sludge alone decreased with increasing concentration of sludge solids until at a (detergent: solids) ratio (4000 ppm sludge solids) stimulation immediately occurred. In case of sewage oxidation, inhibition was again effected and stimulation was not observed until 12 hours contact with a 1:40 (detergent: solids) ratio (4000 ppm sludge solids). This indicates again a greater adverse effect of detergents on the oxidation of sewage matter than on the endogenous respiration of the organisms.

TABLE 3

Effect of Nacconol on Oxygen Uptake of Activated Sludge Alone

1000 ppm Activated Sludge + Nacconol, ppm	Oxygen Uptake (ppm) Hours	
	6	24
0	43	110
50	66	187
100	59	179
200	46	108
350	40	99
500	24	82

Effect of Ceepryn Additions at Various Time Intervals

Cationic Ceepryn, in concentration of 100 ppm was added to activated sludge—sewage mixtures (1000 ppm solids in mixed liquor) immediately and after 1, 2, and 4 hour shaking periods. The general trends are illustrated by the data of a typical run and summarized in Table 4.

When Ceepryn was added initially, a definite suppression of sewage oxidation occurred within the first hour and persisted throughout the 24 hour incubation period. At the end of 6 hours contact, only 50 per cent of oxygen utilization value of the control was exerted. This suppressive action diminished in 24 hours and 80 per cent of the 24 hour control value was realized. When Ceepryn addition was made after 1 hour contact of sludge and sewage, retardation of sewage oxidation was apparent within 1 hour of the addition and was more marked 2 hours after. Only 51.5 per cent of the 6 hour control value was exerted at the 6 hour contact interval (5 hours after detergent addition), but this value increased to 85.5 per cent in 24 hours.

Addition of Ceepryn after 2 hours of shaking demonstrated no influence on sewage oxidation 1 hour after the detergent addition, but inhibition was manifested at the 2nd hour. The 6 hour utilization was 64 per cent of the control value and increased to 90 per cent after 24 hours.

TABLE 4

Effect of Addition of Ceepryn at Various Time Intervals on Oxidation of Sewage by Activated Sludge

1000 ppm Activated Sludge + Sewage	Oxygen Utilization ppm Hours							
	1	2	3	4	5	6	13½	24
Control	34	48	58	78	104	128	176	192
Ceepryn (100 ppm)								
Initially	26	32	38	46	56	64	86	154
After 1 hr.	34*	42	46	52	60	66	96	164
After 2 hr.	34	48*	56	66	76	82	112	174
After 4 hr.	32	46	54	74*	106	124	164	190

*time of detergent addition

Ceepryn addition after 4 hours shaking of the sewage sludge mixture, displayed practically no effect within 2 hours after addition as well as for the total 24 hour aeration period.

The overall mechanism of substrate oxidation by activated sludge involves many concomitant physical and biochemical actions. For materials such as sewage, which possess colloidal and soluble fractions, rapid adsorption of colloidal matter occurs simultaneously with the oxidation of the soluble portion. Hydrolysis of the larger molecules and particles takes place with subsequent oxidation of these materials. The highest rate of oxidation occurs initially and gradually decreases for the succeeding periods of time.

The presence of a detergent such as Ceepryn interferes with the oxidative mechanisms of the activated sludge organisms. Thus, in these experiments, the adverse action of Ceepryn on oxygen utilization was more rapid when added initially; or, in other words, when the highest oxidation rate occurred.

Effect on Adsorption Phenomenon of Activated Sludge

Various approaches were employed to establish the general trends of possible action of detergents on adsorption. One of these approaches included a series of experiments which involved the determination, by chemical means, of the removal of protein by activated sludge in the presence of Nacconol N.R.

A fresh solution of bovine albumin was prepared and added to samples of activated sludge (1000 ppm mixed liquor) in concentration of 300 ppm. Included in the mixed liquors were 50 and 100 ppm of Nacconol. A third sample of sludge was treated initially with 100 ppm of Nacconol; the supernatant was removed and the albumin solution then added. A fourth sample served as control. The mixtures were mechanically shaken for 20 minutes at 20 deg. C., settled and the supernatants removed. Organic nitrogen determinations by Kjeldahl procedure were performed on the supernatants as well as on the original albumin solution and detergent solution.

The results in terms of per cent organic nitrogen removed under the various conditions are briefly given in Table 5.

Nacconol N.R. showed the presence of no organic nitrogen compounds which might interfere with the interpretation of the results. It was observed that 50 ppm of the detergent produced a 40 per cent decrease in the removal of protein by activated sludge. Nacconol in concentration of 100 ppm prevented the adsorption of the protein regardless of the method of detergent addition employed.

TABLE 5

Removal of Albumin by Activated Sludge in Presence of Nacconol

Samples	Organic N Removal %
Control	22.5
With Nacc. 50 ppm	13.6
With Nacc. 100 ppm	0
Pretreat. Nacc. 100 ppm	0

Interference with adsorption of added colloidal matter presumes a rapid initial adsorption of the synthetic detergent. A brief study was undertaken to observe the adsorption of such agents by activated sludge.

Activated sludge (1000 ppm in mixed liquor) was shaken with 100 ppm Nacconol as determined by titration with a cationic detergent solution. The sludge suspension was mixed rapidly for a 5 minute period, allowed to settle and the supernatant was then carefully removed. A total of 4 additions of water and detergent was made in this fashion. The anionic detergent concentration remaining in the supernatants was then determined by titration. A summary of the results in terms of per cent removal of Nacconol by adsorption is presented in Table 6.

The adsorption of detergent by the same sludge with fresh addition of the agent decreased with each passage. No further adsorption of Nacconol was observed in the fourth passage that could be detected by means of the analytical method employed.

Adsorption is considered as the precursor to hydrolysis and oxidation of organic colloidal particles and molecules by the activated sludge organisms. Any interference with this mechanism would consequently appear as a retardation of the oxidation. It must be kept in mind that although adsorption of albumin appeared to be completely suppressed by 100 ppm of Nacconol under the conditions of the experiment, retardation of oxygen utilization of activated sludge—albumin mixtures also involves determent of the oxidative mechanisms.

Effect on Purification and Nitrification Capacities

In a previous paper[1], the effects of repeated additions of detergent on the purification and nitrification capacities of activated sludge were examined. It was found that oxidizable nonionic Tween 80 induced no detrimental effect on activated sludge or its activities. Repeated additions of Nacconol and Ceepryn retarded the oxidizing capacity of the activated sludge organisms resulting in a decrease in purification efficiency. Repeated additions of these ionic agents first suppressed the activity of the nitrite oxidizers, then curbed the activity of the ammonia oxidizers and finally interfered with ammonification. An overall and general deterioration of the physical and biological properties of activated sludge occurred. The adverse effects took place in a shorter period of time with cationic Ceepryn than with Nacconol and with the higher concentrations of the detergents. However, repeated additions of 10 ppm of the detergents produced a similar harmful pattern over a relatively short period of time of one week in these laboratory studies.

Discussion

Recognition of the ability of synthetic detergents to act rapidly and extensively in both physical and chemical fashion, when present even in low concentrations has drawn attention to their effect on sewage treatment devices and sewage purification. An important and fundamental consideration within the scope of the activity of synthetic detergents is their possible influence on complex, dynamic biological treatment systems.

Theoretical Aspects

The primary mechanisms of interference of toxic materials may follow, in general, two courses of action: (a) inhibition of the catabolic, energy-releasing reactions and systems—characterized by a general nonspecific effect; (b) inhibition of the anabolic, energy-utilizing reactions—usually involving a selective effect on any specific enzyme or metabolic step.

Synthetic detergents are highly varied in chemical structure, have a large range of action, and produce a similar and general overall retardation of metabolic processes of many microbial forms. These agents can be classified among those affecting the degradative processes of the cell and can be measured by means of the dimunition in oxygen utilization.

Non-ionic Tween 80, possessing no dissociable polar groups, was incapable of interacting, electrostatically, with cellular structures. It was demonstrated that this agent is biologically oxidizable and therefore, manifests no adverse effect on activated sludge or its activity.

The anionic and cationic detergents studied are capable of interaction with cellular structures to form poorly dissociable complexes, consequently affecting activated sludge, its characteristics and mechanisms.

The degree of interaction is a function of the pH of the medium. The negatively charged agent, Nacconol, displayed a greater adverse effect on sewage oxidation at acid pH values; whereas, the cationic agent Ceepryn, exhibited increasing suppression as the pH values become more alkaline.

It was observed that, in general, endogenous respiration of the activated sludge organisms was affected to a lesser degree than the oxidative mechanisms; which, in turn, are suppressed to a greater degree when substrate oxidation is occurring at a rapid rate.

Other effects attributed to synthetic detergents also play a definite role in the determent of activated sludge activity. Included among these is the interference with adsorption of colloidal food material by activated sludge.

Operational Aspects

The effect of synthetic detergents on operational efficiency of activated sludge processes obviously will depend on the type and concentration of the agent present. The most common type of surface active agent encountered in sewage treatment belongs to the anionic alkyl aryl sulfonate class (Nacconol).

The presence of anionic Nacconol will therefore adversely affect the adsorptive, purification and nitrification capacities of activated sludge. Any decrease in pH of the aeration tank contents, due possibly to the inclusion of an industrial waste, will increase the suppressive action of this agent on oxidation. Increase in solids content of activated sludge will aid in diminishing the drastic action of the ionic agents studied.

Agents such as nonionic Tween 80 which are biologically oxidizable will exert no harmful influence on the activated sludge process except for possible additional load under circumstances of excessive discharge and overloaded conditions.

Extrapolation of laboratory results to field conditions must be interpreted carefully with regard to the extent and rapidity of the effects produced by synthetic detergents on the basis of such factors as: (a) continuous flow process, (b) wasting of sludge, (c) sludge age, (d) variable discharge of detergents and (e) type and concentration of agent present.

TABLE 6

Adsorption of Nacconol by Activated Sludge

Detergent Passage	Nacconol Removal %
1	25.4
2	14.2
3	2.6
4	0

Summary and Conclusions

Laboratory experiments were conducted to study the effects of synthetic detergents on the activities and characteristics of the active, aerobic, biological community composing activated sludge. Representatives of the three main types of surface active agents were employed in this work. These agents included: (a) the common anionic type, Nacconol, (b) the cationic agent Ceepryn with specialized application and (c) nonionic type —Tween 80—as yet in limited use.

From the results obtained the following conclusions may be drawn with regard to principal effects and general trends:

1. The effect of synthetic detergents on activated sludge depends on the type of syndet and the concentration present in sewage.

a. Both anionic and cationic detergents studied are capable of affecting activated sludge characteristics and mechanisms.

b. Non-ionic Tween-80 was oxidizable and therefore had no adverse effect on activated sludge or its activity.

c. The adverse action of the ionic syndets, in general, occurs more rapidly and to a greater degree with increasing concentration of detergent.

2. Anionic Nacconol is rapidly adsorbed by activated sludge and subsequently interferes with adsorption by the sludge of colloidal food material.

3. The degree of interaction of anionic and cationic syndets (Nacconol and Ceepryn) is a function of pH of the medium.

a. Negatively charged Nacconol caused a greater adverse effect on sewage oxidation at acid pH values.

b. Cationic Ceepryn produced an increasing inhibition as the pH values became more alkaline.

c. Non-ionic Tween 80 is oxidized over a range of pH values.

4. In general, endogenous repiration of the activated sludge organisms was affected to a lesser degree than the oxidative mechanisms.

a. Oxygen uptake of activated sludge itself in the presence of cationic Ceepryn followed the same trend at various pH levels as the sewage-sludge mixtures, but to a lesser degree.

b. Oxygen uptake by activated sludge itself is stimulated by anionic Nacconol. This stimulation is greater at neutral pH but this action may reveit to suppressive influence with an increase in syndet concentration.

5. Retardation by ionic detergents employed, of the oxidation of sewage by activated sludge decreases with an increase in mixed liquor solids concentration. The action depends on the detergent-sludge solids ratio. Increasing the sludge solids content will aid in diminishing the drastic effect of the ionic and cationic syndets studies.

6. Repeated additions of anionic Nacconol and cationic Ceepryn cause a decrease in oxidizing, purifying, and nitrifying capacities of activated sludge accompanied by a general deterioration of its physical and biological properties.

7. The adverse action of synthetic detergents involves the degradative or energy-releasing reactions and mechanisms.

Reference:

(1) Manganelli, R., and Crosby, E., "Effect of Detergents on Sewage Microorganisms". Sew. and Ind. Wastes, *25*: 3, 262(1953)

Water Research Grants Total Almost a Million

According to Harry A. Faber, Research Coordinator for the U. S. Public Health Service, grants approved for research in water treatment and waste disposal in the last six months of 1955 has reached the figure of almost one million dollars.

Practically all of this money will go to colleges and universities. The largest single amount granted is the $21,850 made to the Univ. of Florida for "a comprehensive study of water coagulation" to be made under the direction of Dr. A. P. Black.

Next largest is the grant of $20,648 to the Univ. of Illinois for a study of "the effects of various water treatments on the carrying capacity of water mains." A progress report on this study was made by Professor T. E. Larson, Chief of the Illinois Water Survey, before the A.W.W.A. at the St. Louis Convention.

In all twenty four grants have been made through the U.S. Public Health Service, approaching the total of $1,000,000.

SEWAGE WORKS PRACTICES

The Activated Sludge Process

And Some Recent Developments

The fifth article of a series

by THEODORE JAFFE

Mr. Jaffe is Professor of Civil Engineering, Alabama Polytechnic Institute, Auburn, Ala. In this series of articles for the practical sewage treatment plant operator, he discusses matters of interest generally overlooked in the press of routine duties.

THE ACTIVATED sludge process is in itself a recent development in sewage treatment. It was discovered and recognized as a useful method of sewage treatment by W. T. Lockett in 1913, although a great deal of previous work had been done by Black and Phelps. Since then, many plants throughout the world have employed this process in its original form to produce a clear, sparkling effluent. In recent years many modifications have been proposed attempting to increase loadings, reduce operating costs, improve efficiency, or simplify operation. This article will present some modifications and variations.

Conventional Process

To better understand the changes suggested or practiced, a brief explanation of the "conventional" activated sludge process is in order. The activated sludge process is a secondary treatment process of the biologi-

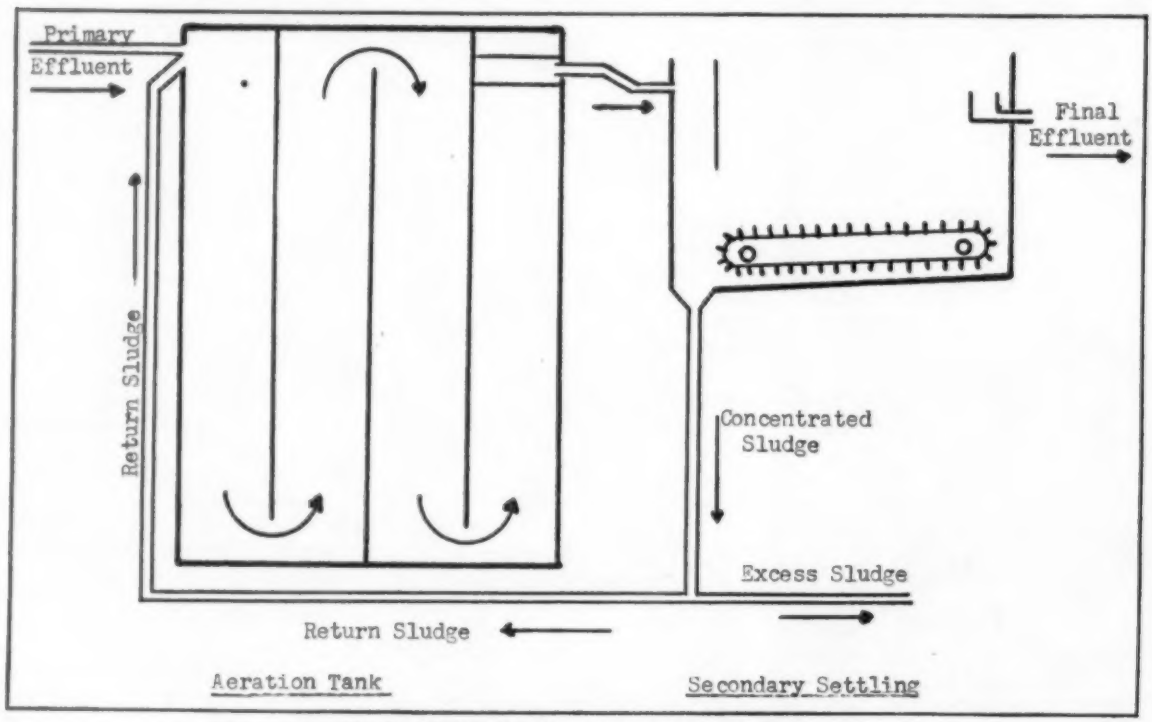

Fig. 1—CONVENTIONAL activated sludge process

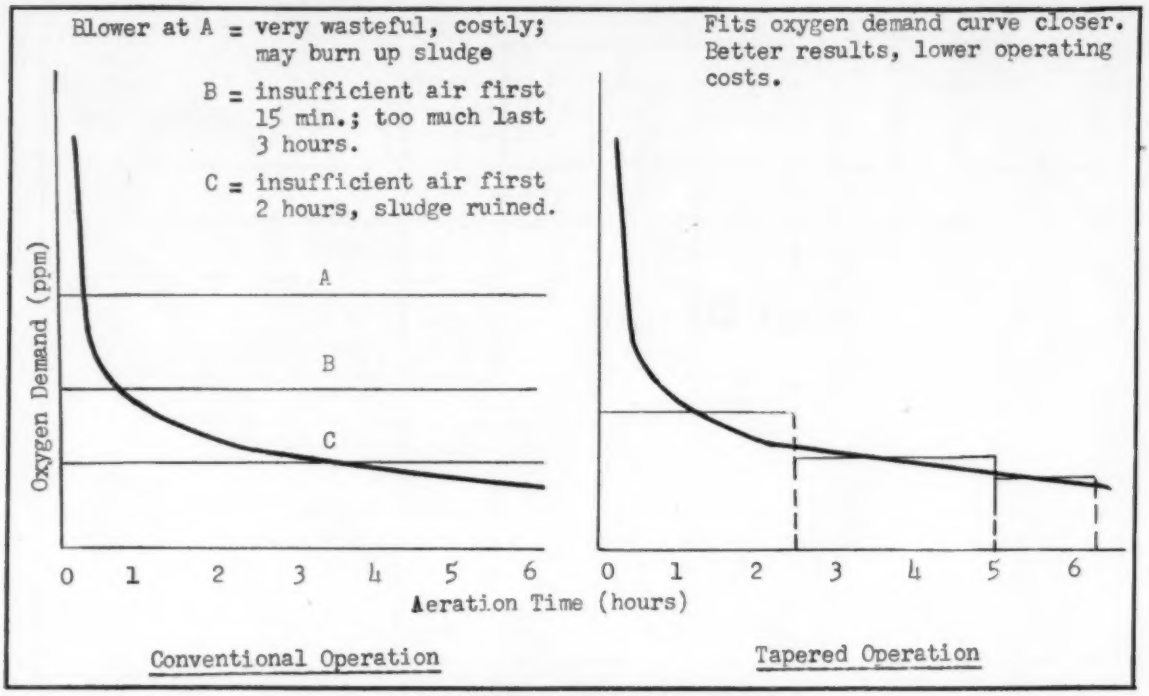
Blower at A = very wasteful, costly; may burn up sludge
B = insufficient air first 15 min.; too much last 3 hours.
C = insufficient air first 2 hours, sludge ruined.
Fits oxygen demand curve closer. Better results, lower operating costs.
Oxygen Demand (ppm)
A
B
C
0 1 2 3 4 5 6
0 1 2 3 4 5 6
Aeration Time (hours)
Conventional Operation
Tapered Operation

Fig. 2—TAPERED vs conventional aeration

cal contact type. This means first, that some form of primary treatment or sedimentation will usually be found ahead of the activated sludge units; second, that it is a process in which the sewage (primary effluent) is brought into intimate contact with various forms of biological life. The heart of the activated sludge process is the aeration tank in which the sewage and the microorganisms (in the mixed liquor) are intimately mixed and aerated.

A flow diagram of a conventional activated sludge plant is shown in Fig. 1. It can be seen here that the following units are required: Primary sedimentation tanks; aeration tanks; secondary settling tanks; sludge treatment and disposal. In comparison with a primary treatment plant we have added the aeration units and the secondary sedimentation tanks; in comparison with a trickling filter plant, we have replaced the filter with the aeration units. All other major units are similar.

How does the process work? Any secondary treatment process is aimed at removing colloidal and dissolved matter from the sewage. Usually gravity is employed to remove the settleable and suspended matter in the primary sedimentation tanks. Then the primary effluent, which contains the colloidal and dissolved matter (as well as the remaining suspended matter) is taken to other units where microorganisms, in either trickling filters, sand filters, or activated sludge, complete the removal job. In these secondary treatment units the "bugs" utilize the solids in the sewage as food materials and in the presence of oxygen, convert these unstable, oxygen demanding substances into stable odorless compounds having no oxygen demand. This is secondary sewage treatment.

In the activated sludge process this stabilization of sewage is accomplished by mixing the primary effluent (containing the food-stuffs for the microbes) with the mixed liquor (containing enormous numbers of "bugs") and supplying air either by diffusion or mechanically. The air furnishes oxygen and does a thorough job of bringing the microorganisms into intimate contact with their food. After about four to six hours aeration, the entire mixture is removed to the secondary sedimentation tanks where a separation of liquid and solids occurs. The liquid is removed as the plant effluent and can be discharged—usually after chlorination.

The solids settling in the secondary tanks compact somewhat, and are split into two portions—excess or waste sludge, and return sludge. The excess sludge may receive further dewatering and then be disposed of by any of the conventional methods. The return sludge is recycled back into the aeration tanks to be used again in the adsorption and clarification process. It is this return sludge combined with the primary effluent that is termed the mixed liquor.

In this manner, the activated sludge process will remove about 90-95 per cent of the B.O.D., and about 95-98 per cent of the suspended solids from the raw sewage. It will produce an effluent containing from 10-20 ppm of B.O.D. and suspended solids. These are average figures to be expected for efficiently operated plants.

As this conventional method of activated sludge treatment came into more common use, various modifications of the process were tried. Some of these were not successful, but other variations have proven useful. In general, these variations may be divided into two categories: (a) modifications of operation while employing the same basic structures; (b) those employing modifications of the basic structures.

Modifications of Operation

In a diffused air activated sludge plant, one of the largest operating cost factors is that of air. Early in the history of the process two different approaches were conceived to reduce this cost. One of these led to the "Tapered Aeration" process, the other to "Step-Aeration."

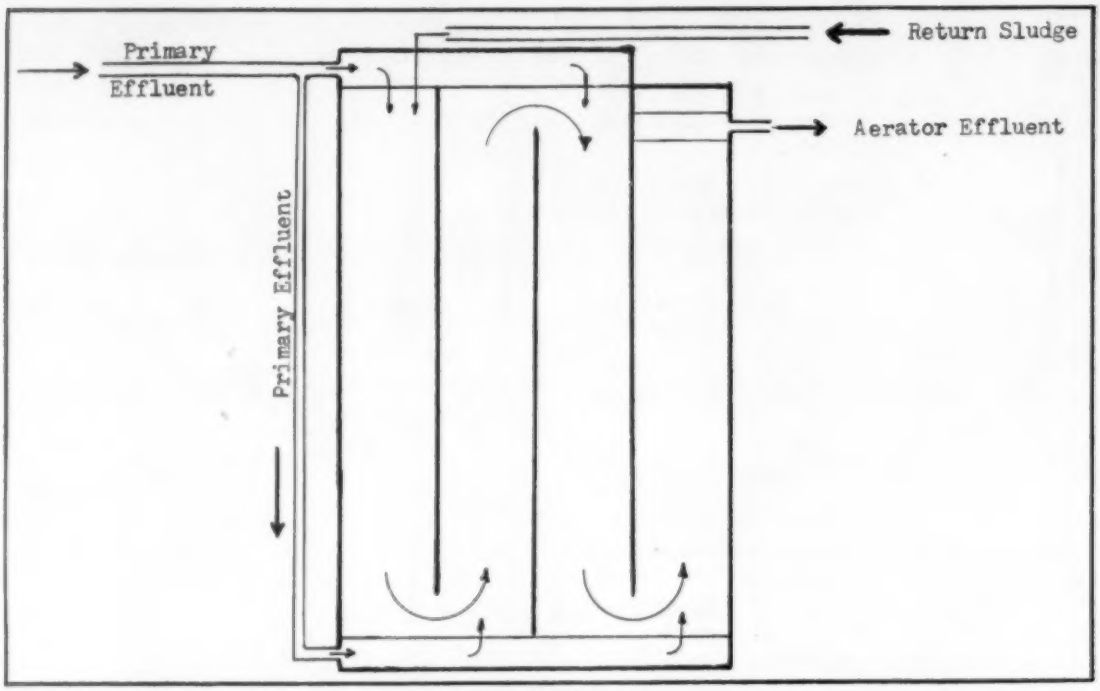

Fig. 3—STEP-AERATION

Tapered aeration was based on the knowledge that the oxygen supplied to the aeration tanks is not utilized at a uniform rate throughout the tank (Fig. 2). During the first two hours about 40 to 50 per cent of the air is required, 28 to 31 per cent in the second two hours, and 20 to 29 per cent in the third two hours, where six hours of aeration are provided. On this basis, it was proposed[8] that the air supplied be made to conform to these requirements. The air supply would be adjusted either by increasing the diffuser area at the inlet end, or by using a large amount of air at the inlet and smaller amounts along the tank. The advantages claimed for this modification are more economical operation and greater control of the process.

The Step-aeration process also seeks greater economy of operation and reduction of cost, as well as better control. In a conventional type aeration tank, where the entire load is introduced at the inlet, it has been found that for about the first quarter or third of the tank, the dissolved oxygen content of the mixed liquor is often zero. Apparently, although sufficient oxygen was supplied, the bugs simply could not handle the load. They could work on the organic matter at a certain maximum rate, and could not be pushed away further.

With this idea, it seemed reasonable to add only a portion of the load at the inlet, another portion at the quarter or third point, another further on and so forth, (Fig. 3). This would serve several purposes—(a) the microorganisms would be working at a more uniform and more efficient rate; (b) there would be no

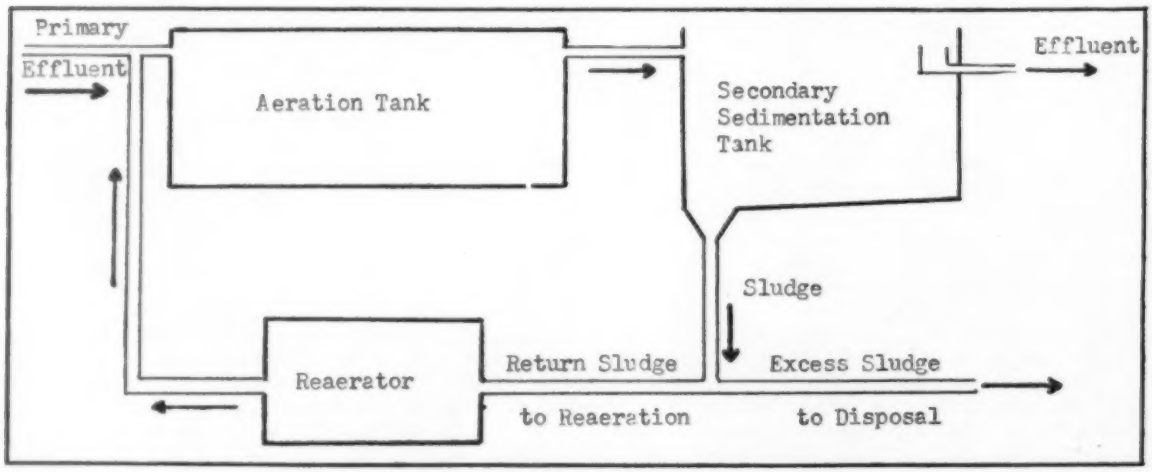

Fig. 4—REAERATION of sludge

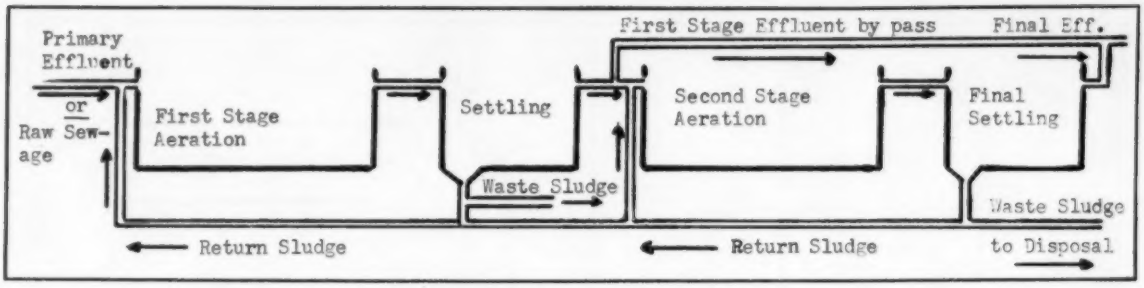

Fig. 5—TWO STAGE aeration operation

zero D.O. spots; (c) better control with a more uniform air supply would be possible; (d) greater economy since the bugs would be utilized to better advantage—no more too much and too little food. This is the step-aeration process[13].

Another modification of the activated sludge process is called "High Rate" or "Low Solids Activated Sludge Treatment" and was reported by Setter and Edwards[12] and others. The high rate refers to a shorter aeration period of about two to three hours, and a lower air input of 0.5 cu ft per gal. The low solids refer to the smaller amount of sludge returned to the aeration tank. This may be as low as 10 per cent of the sewage flow, compared to the usual 20 to 25 per cent returned in the conventional process. Since a smaller amount of sludge is returned, the suspended solids in the mixed liquor of the aeration unit is kept below 800 ppm as compared to 2000 to 3000 ppm in the usual method.

What results can you expect from this modification? The B.O.D. and suspended solids removals will be smaller, but this high rate-low solids method is recommended as an intermediate form of treatment. It is designed so that any degree of stabilization of sewage can be given between that produced by primary treatment and that from the conventional activated sludge process, at a low cost.

Two Phases to Activate Sludge Process

The activated sludge process basically consists of two distinct phases. When the primary effluent is mixed with the returned sludge in the aeration tank the first phase, that of ad-

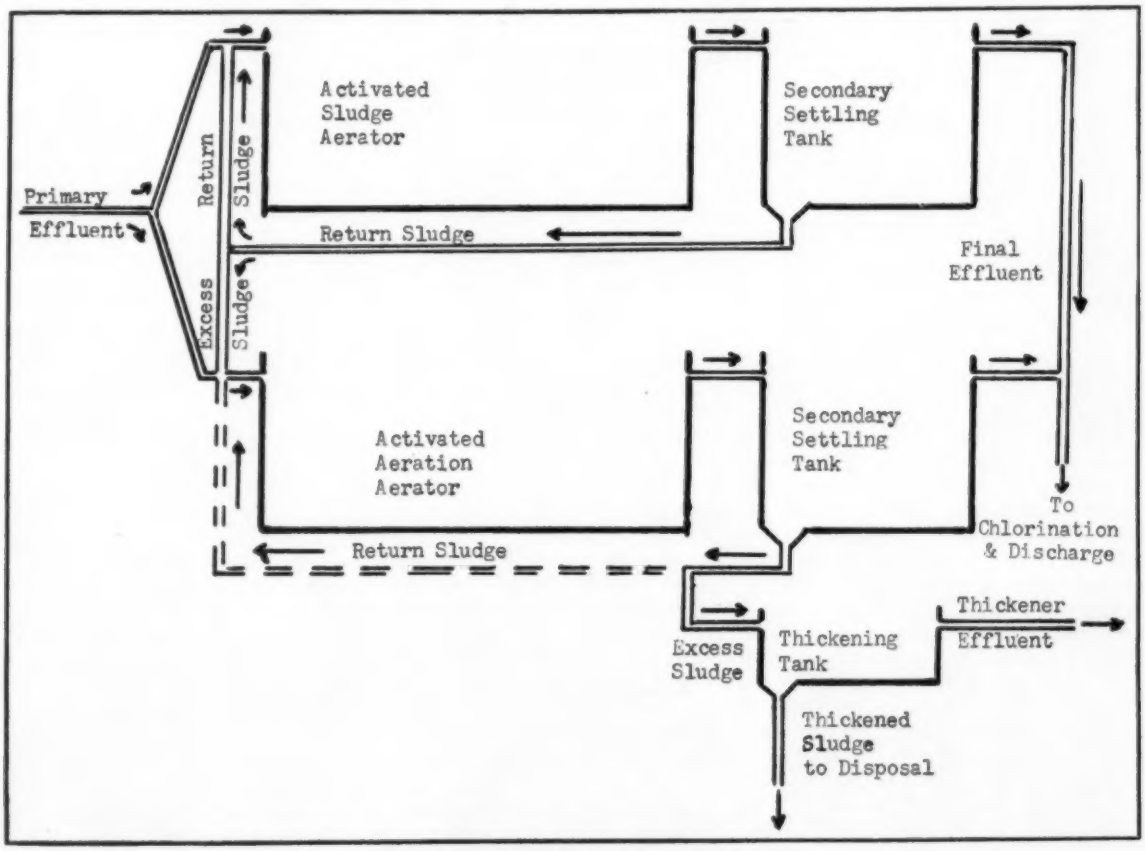

Fig. 6—ACTIVATED aeration operation

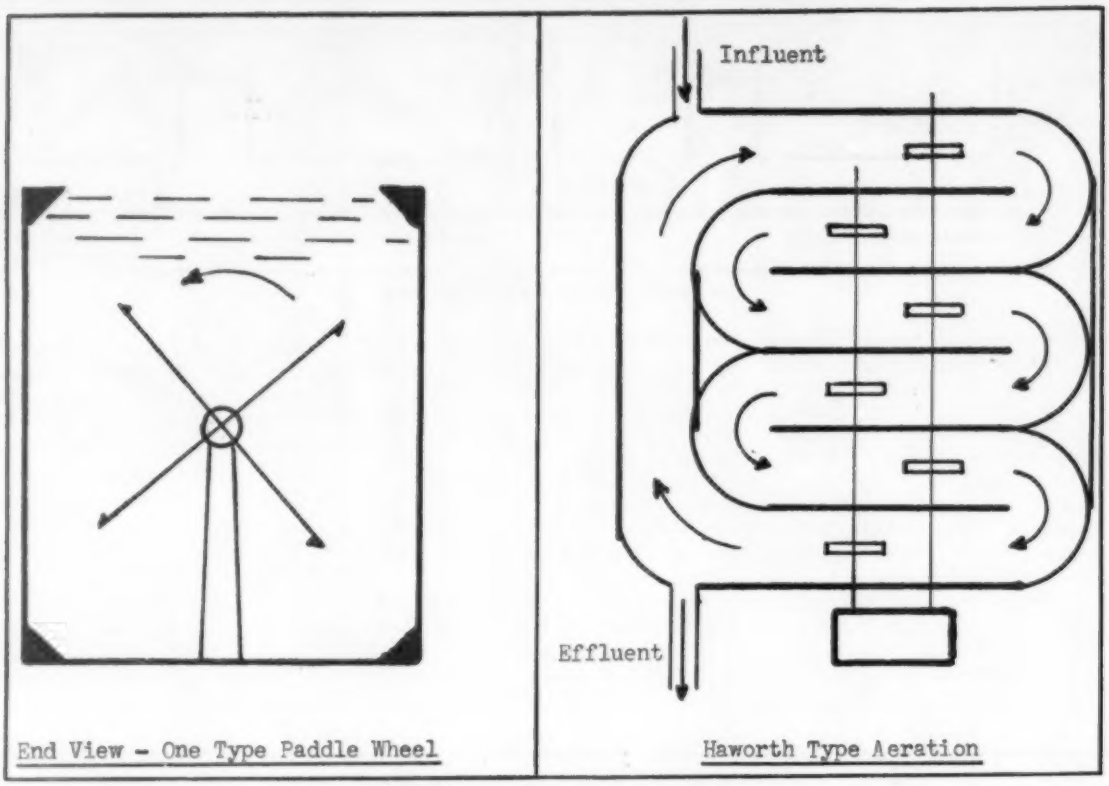

Fig. 7—TWO TYPES of paddle wheel aeration units

sorption takes place. The organic matter of the sewage sticks on the surface of the bacterial masses (zoogleal masses), and as a result of this the sewage begins to look clear. It is no longer milky in appearance. This clarification of the sewage usually takes about 1 to 1.5 hours. While the zoogleal masses are adsorbing all they can hold, the microorganisms begin to eat the organic matter stuck to their homes. This eating is an oxidation process requiring oxygen, and constitutes the second phase of the activated sludge process.

Since the organisms have a maximum eating rate, and since this rate depends upon many factors, the oxidation stage usually takes a longer time and requires closer attention by the operator. In the conventional process most of this action—both stages—takes place in the aeration unit, and usually requires about six hours. From here, the mixture is sent to the secondary settling tanks where the stabilization is completed and the clarified liquor separated from the sludge by gravity. Part of the sludge is then recycled to the aeration unit as previously described.

Very early in the development of the activated sludge process, as far back as 1917, it was shown that the two phases could be acomplished in separate tanks. What was the advantage of this? The adsorption stage does not require oxygen; the only requirement here is adequate, thorough mixing of the sewage with a good, hungry, return sludge. The second phase above required oxygen for the oxidation of the organic matter. If now, the two phases or stages were to be separated, couldn't there be some saving of air and thereby a reduction in the operating cost? This would be possible except for one thing —if we supplied air for oxidation in the secondary sedimentation tank, the air would seriously interfere with the settling efficiency.

The idea needed one further step. The fresh, young sludge to be returned could be taken off into one tank and aerated; the old, excess waste sludge could be run into another tank where the separation of the clarified liquor from the sludge could take place. Now the process worked and it was called "Sludge Reaeration" (Fig. 4). There are many other trade names associated with this basic idea, each having its own variation[14].

Stage Operation

One further modification, that of "Stage Operation," need be mentioned. At various times in the past, the activated sludge process has been combined with trickling filters. The filters have been used both ahead of the aeration units and after them. The main advantages sought by these combinations were (a) reduced aeration costs through allowing the filters to do part of the purification, and (b) less critical operation of the activated sludge process. Activated sludge is easily upset by variations in flow, loading, or character of the waste. This requires careful and continuous operation. By preceding the aeration units with filters, a smoothing out of the waste entering the aeration units is accomplished, and less critical operation is necessary.

The name "Stage Operation" has also been applied to sewage stabilization by means of two activated sludge systems in series (Fig. 5). This system has had but limited use in the United States[11], although somewhat more experience has been reported from European plants. Imhoff claims[5] this procedure has the following advantages over single stage operation:

(a) The excess sludge contains less water, has smaller volume, and the first stage sludge settles well.

(b) Requires smaller aeration units.

(c) With a by-pass around the second stage, any degree of partial purification is possible.

(d) Plant operation is easily adjusted to shock overloads.

A somewhat similar system has been employed at the Wards Island Plant by Chasick, who calls his modification "Activated Aeration"[2] The process is primarily aimed at overloaded conventional activated sludge plants and although the amount of over-all removal is somewhat reduced, the effluent quality remains high (about 31 ppm of suspended solids and B.O.D.—nine months operation). By varying the operational factors, it is thought, that efficiencies between straight aeration and full activated sludge can be attained.

Briefly, the process consists of dividing the treatment plant into two operational units (Fig. 6). The flow pattern of the return sludge remains the same; i.e., from the settling units of the group to the inlet of the aeration tank. The excess sludge from the first group however, is pumped to the aeration unit of the second instead of being drawn off for disposal. Since this sludge still retains its "active" condition this is utilized, and assists in the stabilization of the sewage. The excess sludge from the second group of units is finally wasted.

The following additional advantages are claimed for this process:

(a) Reduced air requirements; therefore lower power costs.

(b) Small volumes of excess sludge; therefore smaller digesters.

(c) Possibly greater gas production.

Modifications of the Basic Structures

Early in the development of the activated sludge process, it was suggested that one way in which the operating cost might be reduced would be to mechanically mix the contents of the aeration unit. Since a large proportion of the air supplied is required for mixing, it was thought that operating costs would be considerably less. To accomplish this, paddle wheels were placed in the aeration tanks (Fig. 7). These were rotated in the direction of the rising air-liquid mixture, and in other installations were rotated against the rising air-liquid mixture. This method was called mechanical agitation as contrasted to the diffused air method.

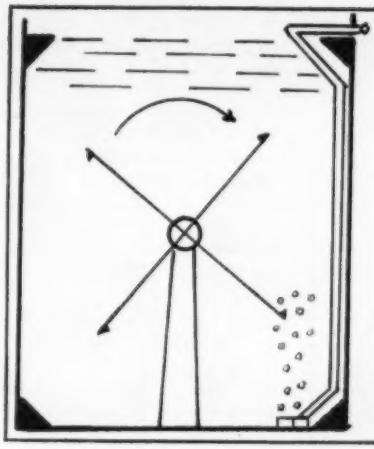

Fig. 8—PADDLE wheel and air type aerator

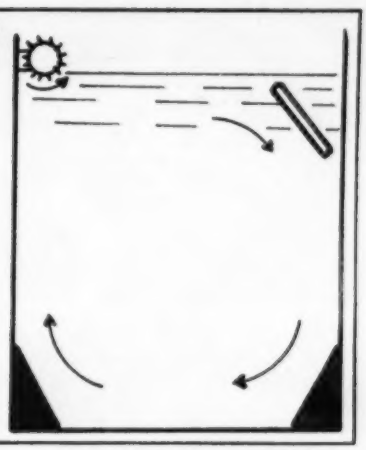

Fig. 9—BRUSH type aerator

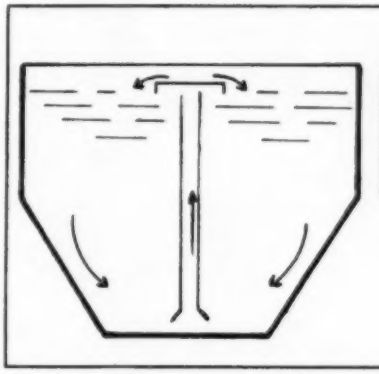

Fig. 10—SPRAY type aerator

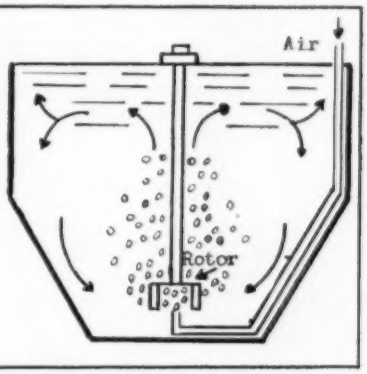

Fig. 11—ROTOR-DISPERSER aerator

One large plant in Sheffield, England[4] was constructed using this paddle-wheel principle.

Another early modification was tried at several plants, notably one in Germany[6]. This was a logical development from preceding methods, in that it combined air diffusion with paddle-wheel agitation. A commercial unit employing this method is shown in Fig. 8.

Attempts have been made to utilize atmospheric oxygen instead of compressed air. The unit devices employed have varied; some types use the same mechanism for circulation and aeration, e.g. the Kessener system (Fig. 9); others employ a mechanical circulation system and a spray or thin-film effect for aeration (Fig. 10). Another design in which the air is dispersed mechanically by a rotor (Fig. 11) which also assists in circulation has been described by this author[7].

Many of the equipment manufacturers have one or more methods of sewage treatment employing air and mechanical circulation. These are known by various trade-names, and are commonly spoken of as "package units." Many of these attempt to treat the raw sewage without any preliminary settling, while others find it advantageous to settle the sewage first. The direction of flow in these units is usually vertical—either up or down flow (Fig. 10 & 11). In the "package-unit" type of plant air is usually supplied either by some form of surface or thin-film contact with the atmosphere, or by introducing compressed air below the liquid surface and using an impeller or rotor to achieve air dispersion, mixing and circulation.

Diffuser Equipment

Many of the developments in the activated sludge process in recent years have sought to obtain greater efficiency through better means of aeration. A great deal of attention is now being paid to the devices used to supply air in the aeration tanks. The usual method has been to force

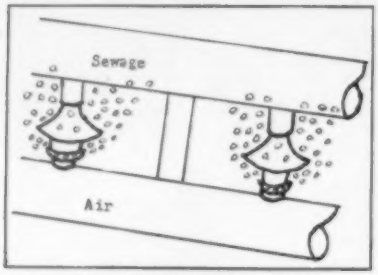

Fig. 12—IMPINGEMENT type aerator

air through porous diffuser plates. These would often become clogged and were quite difficult to clean. New York City has found that spalling (oxyacetylene flame cleaning) of the aeration plates, in place, was effective although in some plants it was necessary to follow the spalling by a jet wash[3].

One of the recent devices attempting to overcome diffuser plate troubles is the plastic-wrapped tube. This consists of a corrugated, stainless steel inner core over which is wound a layer of plastic cord. The air is blown through the inner core of the steel tube and distributed to the diffusing surface through large multiple outlets in the valley of the corrugation. Although some surface clogging due to slime growth does occur after use, it is claimed that this can be easily removed by a high pressure water jet system[1]. When these diffuser tubes are mounted in a swing type assembly, they can be raised to the tank wall for cleaning without any interruption of operation.

Another development along these lines is the jet or impingement type of aerator (Fig. 12). In this system a double set of perforated pipes is used, one placed directly above the other, parallel with the length of the aeration tank and close to the bottom. The mixed liquor is brought in through the upper pipe; the air through the lower. These impinge or are forced against a cone or disc. The air is dispersed into fine bubbles, which are entrained by the downflowing mixed liquor. Due to the air pressure, agitation is accomplished and by the lift effect of the released air in the air-mixed liquor combination, circulation along the tank is achieved.

Dual Aeration

A recent paper[9] has proposed still another modification in aeration technique, called "Dual Aeration." Here air is supplied at two points in a conventional type tank (Fig. 13). Part of the air is supplied adjacent to the tank wall at about one-third of the liquid depth. This is called "distributor air" and is intended to create maximum turbulence. The turbulence, in turn, is intended to "increase oxygen uptake from the air above the liquid surface and also increases the rate of oxygen absorption from the air admitted in small bubbles near the tank bottom"[10]. This bottom air is supplied by diffusers as shown in the figure. The direction of flow in the tank is determined by the location of the diffuser in relation to the distributor. When the diffuser is on the same side as the distributor, "parallel" flow is obtained; with the diffuser diagonally opposite the distributor, "counterflow" results. This latter type of flow is suggested for the usual aeration tanks.

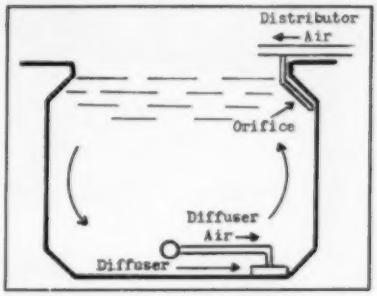

Fig. 13—DUAL AERATOR

Compressed air has many uses in sewage treatment other than in the activated sludge process. These auxiliary uses of air will be discussed in the next article in this series.

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E. F. Hughes Named Gen'l. Superintendent New Orleans S. & W. Board

Edmund F. Hughes who for 29 years has served the Sewage & Water Board of New Orleans has been named general superintendent to succeed the late A. Baldwin Wood.

For the past several years Mr. Hughes had been assistant general superintendent of the Sewage & Water Board. He is a graduate of Tulane University (Bachelor of Eng. 1925) and joined the Sewage & Water Board upon graduation. He left the Board for two years and returned in 1933 after touring Europe and engaging in construc-

tion work in the New Orleans Area.

Mr. Hughes is a member of A.W.A., A.S.C.E., A.P.W.A., the Louisiana Engineering Soc., and the Engineers Club of New Orleans. He is a post-president of the New Orleans Chapter of A.P.W.A. He is 53 years old, married and has three children.

Kivell Joins Firm of Gibbs & Hill, Engineers.

Wayne A. Kivell, retired sanitary sales engineer for years connected with Dorr-Oliver of Stamford, Conn. has joined the staff of Gibbs and Hill, consulting engineers of New York.

Mr. Kivell served the Dorr Co. and Dorr-Oliver for 33 years in the Sanitary Division where he obtained broad experience.

Hats Off To—

An open letter from one reader to all others about
Mr. Water & Sewage Works.

Dear Bill,

Perhaps this is an unusual letter to be writing to you, but then I'm writing about an unusual man. And the reason is this: Linn Enslow is just completing his 25th year as Editor of *Water & Sewage Works*—doesn't really seem like it, does it—and the publisher of this magazine asked me to write something about him to mark the occasion.

It was not that I've known him longer or that I am closer to him than anyone else, but our paths have crossed, recrossed and intertwined on many occasions over a long period—and I do know something about his work as editor of the magazine. Naturally, I was quite pleased with the assignment and the first thing I want to say is to ask you (and every other reader) to write a personal note to Linn congratulating him on this, his silver anniversary as editor of this magazine.—Will you do that, right away?

Our First Meeting

I first met Linn Enslow in 1927 in Detroit at the meeting of the American Chemical Society. I was a student at the time, attending my first ACS meeting. I remember, my professor (Dr. Buswell), Dr. Willem Rudolfs and I were Mr. Enslow's guests for lunch that day at the Book Cadillac Hotel. At the time, he was Research and Development Engineer for The Chlorine Institute and I sat quietly listening to these three discuss the use of chlorine in water and sewage treatment. I knew then that I was listening to a man who not only was, but would continue to be, an important personage in the field of water and sewage treatment.

In 1933, I attended my first AWWA Convention at the Hotel Sherman in Chicago. I was fresh out of graduate school and looking for a job. Of course I talked with Mr. Enslow, by then the Editor of *Water Works & Sewage*. At the time he had no particularly definite suggestions and neither of us suspected that ten years later he would be very instrumental in my decision to change jobs, a decision that was to see our paths intertwined.

Over the years of attending both water and sewage conventions, I have seen Linn Enslow at countless conventions and I have watched him in action; I have seen him with his ever present camera, pencil and notebook and I have watched his readiness to get on his feet to comment on a paper, or to ask questions of the speaker. Many an open forum has been kept from dying by the penetrating questioning of Mr. Enslow.

I've been told that at one convention, during the floor discussion of a paper, Linn conceived a device to determine the corrosivity or stability of a water. The device was later produced and marketed under the name, "The Enslow Stability Indicator." There is also an "Enslow Chlorine Comparator" for making residual chlorine determinations and there are other gadgets as well, which he has suggested to operators all over the country.

Some Professional History

In case you didn't know, Linn was graduated in 1912 with a B.S. in Engineering Chemistry from Virginia Polytechnic Institute. He broke into the water works business via the Maryland State Dept. of Health after two years with the General Chemical Co. It was at the Maryland Health Dept. that he became acquainted and associated with Dr. Abel Wolman and it was these two who first proposed and used the ortho-tolidine test for the control of water chlorination by the all important residual chlorine method.

From Maryland, Linn went to the water works at Spartansburg, S.C. for a short period and then on to the water works in the Panama Canal Zone, where he was associated with Dr. George C. Bunker. Two years in Panama was enough "foreign service" and he came back to his beloved Virginia to spend five years as chemist in the Virginia State Health Dept. Next, the Chlorine Institute beckoned and, for six years, there was hardly a water works or sewage plant, in the U.S., using chlorine that did not see Linn Enslow. Then on October 1, 1931, he joined the staff of *Water Works & Sewerage* (now *Water & Sewage Works*) and the saga of his editorship began.

The Stories They Tell

They tell lots of stories about Linn Enslow—about how, when he came to New York his southern accent was so thick he couldn't call telephone numbers that contained a four because the operator couldn't understand him;—about the time he got off a train to get some cigarettes and the train went on without him;—about how he loves to go to the Portland, Me. meeting of the Maine Water Utilities Assn., because he loves the doughnuts (or donuts) they present him with there;—about his penchant for working late at night when other people sleep;—about his almost nonchalant disregard of time table schedules and the number of times he has raced after a train starting down the track (and missed one);—about the time in a famous court case when he said a polluted river had 1 ppm or less of H_2S in it, and when the judge asked how he knew, Linn said he depended on his nose and experience (P.S.—a test made at the judge's request showed 1 ppm of H_2S);—about his photographic memory for people, places and things;—about his special "pipe-papers" for making little balls of tobacco to smoke in his pipe; and about his love of good food, and fun.

Honors and Awards

In this category there is much to tell about—About how he served in World War I with the 1st Maryland Cavalry and in World War II as Consultant of the War Production Board. They can tell of his many honors and awards: He's a Past President and Honorary Member of the AWWA, a Diven Medalist, a Goodell Awardee, a Fuller Awardee and for a long time was Chairman of the Publications Committee of AWWA. He's a past President of the N.Y. Sew. and Ind. Wastes Assn. and was Vice-chairman of the Board of Control of the Federation of Sewage Works Assns. in its early days. He has served on the Board of Governors and Exec. Comm. of the Water & Sewage Works Manufacturers Assn. and is a Past Chairman of the Sanitary Engineering Division of ASCE. In addition he is a member of APWA, APHA (Fellow), NEWWA, AIChE, and many state or sectional organizations.

All of these accomplishments have been achieved while he carried on his job as Editor of *Water & Sewage Works*. And I need not tell you what a tremendous job he has done in that regard. And you know too, that Mr. Enslow's imprint is on the magazine throughout.

Well—This is my way of saying "Hats Off To Mr. *Water & Sewage Works*" on this, his silver anniversary and I do hope you will write him a note too.

Yours,

"Doc"

THE PUBLISHER SPEAKS

An Outstanding Editor Has A Silver Anniversary

It is with great pride that we of the Scranton Publishing Co. dedicate this issue of *Water & Sewage Works* to Linn Harrison Enslow, Editor.

Outwardly, the magazine has the same general appearance of previous issues. What makes it special is the fact that with the publication of this September 1956 issue, Linn Enslow has completed 25 years of service as Editor of *Water & Sewage Works*.

Linn H. Enslow
Editor

It was October 1, 1931 that Linn Enslow left his position as Research Engineer of the Chlorine Institute and joined our staff as Editor of *Water Works & Sewerage*, as it was then known. In the 25 years that followed, under Enslow's guidance, many changes, many improvements and many firsts in technical journalism followed. We are proud of these changes and improvements.

We are proud of the gain (nearly ten fold) in advertising pages carried; we are proud of the gain in subscriptions; (nearly ten fold); we are proud of the renewal percentages of our paid subscriptions (between 75 and 80 per cent for more than 10 years now). These are the commercial signs of success of a magazine, but we are even more proud of the place this magazine occupies in the field of water supply, sewage disposal and waste treatment, for we believe that the interests of the subscriber come first.

We recognize fully that the interests of the subscriber are best served by an alert and energetic editor who is both experienced and well informed in the technical aspects of the field he serves.

Linn Enslow brought to this magazine, and indeed to the whole field of journalism in this field, new concepts of editing a magazine for the benefit of the readers. He introduced new ideas on content and format. Over the years he has sought out original articles of both technical and general informative interest. The list of authors whose articles have appeared in *Water & Sewage Works* reads like a veritable "Who's Who" of the water and sewage works field. At the same time he has encouraged the small plant operator to write about his problems and to read about other's problems like his.

It was Linn Enslow who introduced in this field the informative style of reporting technical meetings and conventions, and it was he who started taking pictures of the association "brass" and "programmers" for inclusion with those reports. Linn also pioneered other editorial features in the field, such as the informative series of technical articles that have appeared over the years, series on small plant operation, the folksy "Dear Bill" Letters, etc. It was Linn Enslow who started the annual *Reference & Data edition of Water & Sewage Works*, an issue often referred to as the "Operator's Bible."

Mr. Enslow's leadership as an editor is reflected in the attitude of the reading public in this field. For many years now, various readership polls conducted by independent organizations for equipment manufacturers, have shown *Water & Sewage Works* to be in first place or only slightly behind the *AWWA Journal* in importance to the men in the field. This consistent attitude among consulting engineers, small plant operators, large plant operators, managers, superintendents, and public health engineers is indeed gratifying to to the publisher for it indicates a well edited magazine.

Linn Enslow's leadership in the field of water and sewage treatment is attested by the many honors which have come to him in these past 25 years. Our magazine is justly proud of these accolades which he has received. We cannot cover them in this short space but we have asked an old friend of our editor to comment on them in a "Dear Bill Letter" which also appears in this issue.

The success with which Linn Enslow's efforts have been crowned in the past 25 years is exemplified in the comparison of a bound volume of the 1931 *Water Works & Sewerage* with a bound volume of the 1955 *Water & Sewage Works*. On this 25th anniversary, we are happy to dedicate this issue to Linn Harrison Enslow, Editor.

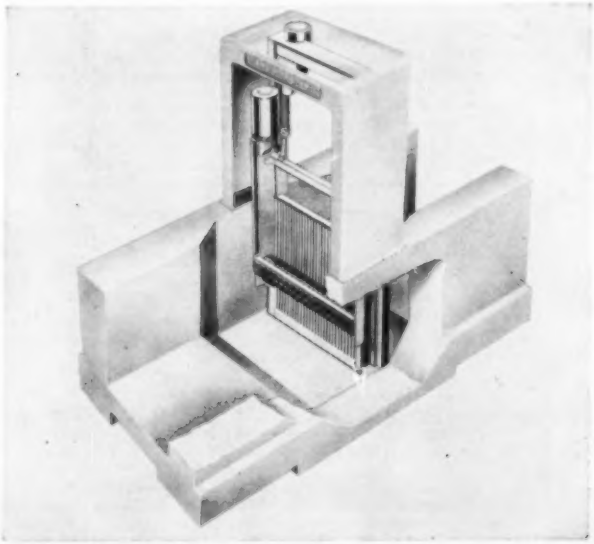
E. Scranton Gillette
Publisher

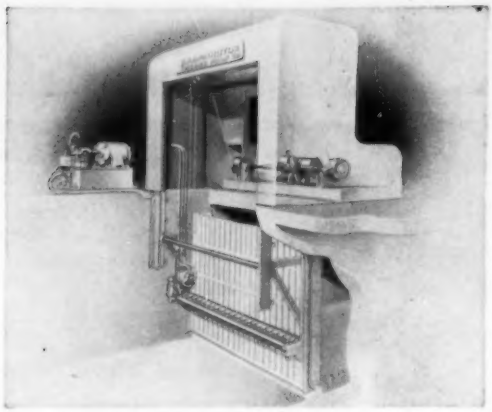
Greater Flexibility in Comminution*

For Sewage Flows From .005 to 250 MGD Per Machine Installed In A 6" Pipe, A Basin Or A Rectangular Channel Section.

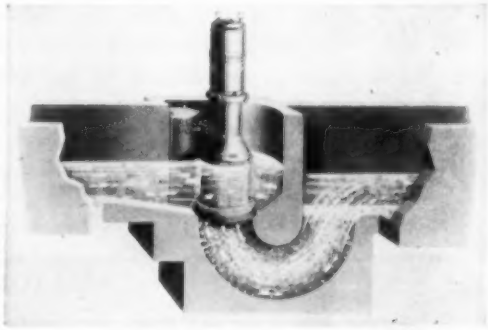
The greater flexibility and wide applicability of comminution made possible by the equipment illustrated here is the result of Chicago Pump Company's original development of comminution and the Comminutor and its 20 years of experience in over 4000 installations of exclusively successful comminution.

**Continuous screening and subsurface cutting of coarse sewage material without removal from the sewage flow, eliminating unsightly mess, nuisance and odor from screenings.*





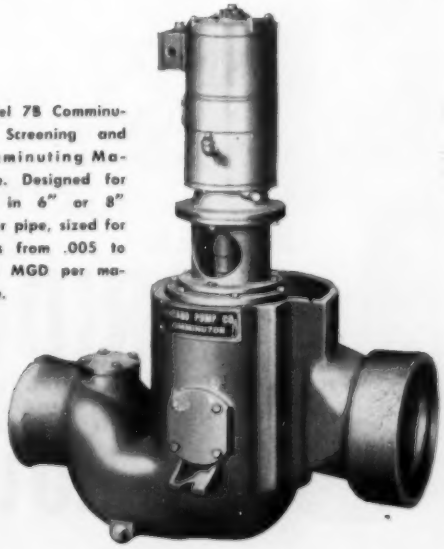
Model "A" Barminutor Screening and Comminuting Machine. Designed for use in rectangular channel sections 4 to 12 feet wide, sized for flows of 10 MGD and upwards.



The Comminutor Screening and Comminuting Machine. Designed for use in hydraulically designed feeder basin, sized for flows from .175 to 25 MGD per machine.

◀ Model "B" Barminutor Screening and Comminuting Machine. Designed for use in rectangular channel sections 1 to 3 feet wide, sized for flows from .09 to 15 MGD.

Model 7B Comminutor Screening and Comminuting Machine. Designed for use in 6" or 8" sewer pipe, sized for flows from .005 to .175 MGD per machine.



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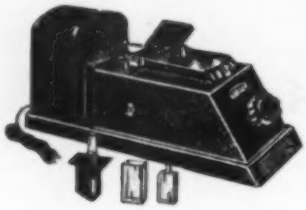

Can be used for any determination in which color turbidity can be developed in proportion to substance to be determined.

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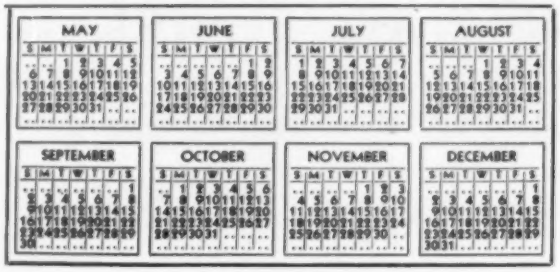


Sept. 9-12—Pittsburgh, Pa. (*Wm. Penn Hotel*)
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, F. J. Van Antwerpen, 25 West 45th St., New York 36, N. Y.

Sept. 12-14—Bolton Landing, Lake George, N. Y. (*Sagamore Inn*)
NEW YORK SECTION, A.W.W.A., Secy., Kimball Blanchard, 56 Grand St., White Plains, N. Y.

Sept. 12-14—Clear Lake, Iowa (*P. M. Park*)
IOWA SEWAGE & INDUSTRIAL WASTES ASSN., L. F. Skorczeski, Secy.-Treas. 207 South 15th Avenue, Marshalltown, Iowa.

Sept. 12-14—Kalamazoo, Michigan (*Burdick Hotel*)
MICHIGAN SECTION, A.W.W.A., Secy., T. L. Vander Velde, Mich. Dept. of Health, Lansing 4, Mich.

Sept. 12-14—St. Paul, Minn. (*Lowry Hotel*)
NORTH CENTRAL SECTION A.W.W.A., Secy., Leonard N. Thompson, Gen. Manager, Water Dept., St. Paul 2, Minn.

Sept. 16-19—Bretton Woods, N. H. (*Mt. Washington Hotel*)
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, N.E.W.W.A., 73 Tremont St., Boston 8, Mass.

Sept. 17-19—Chattanooga, Tenn. (*Hotel Patten*)
KENTUCKY-TENN. SECTION, A.W.W.A., Secy., J. Wiley Finney, Jr., Howard K. Bell Engrs., 533 S. Limestone St., Lexington, Ky.

(*Jointly With*)

KENTUCKY-TENN. INDUSTRIAL WASTES & SEWAGE WORKS ASSN., S. Leary Jones, Secy.-Treas., Cordell Hull Building, Nashville, Tenn.

Sept. 19-21—Atlanta, Georgia (*Georgia Tech.*)
GEORGIA WATER & SEWAGE ASSN., 25th Annual Georgia Water & Sewage School, Georgia Institute of Technology, A. T. Storey, Secy.-Treas., 1210 Hemphill Ave., N. W., Atlanta, Ga.

Sept. 19-21—Toledo, Ohio (*Commodore Perry Hotel*)
OHIO SECTION, A.W.W.A., Secy., M. E. Druly, Dist. Mgr., Dayton Power & Light Co., Wilmington, Ohio.

Sept. 19-21—Aberdeen, So. Dakota (*The Sherman*)
SOUTH DAKOTA WATER & SEWAGE WORKS CONFERENCE, Charles E. Carl, Secy.-Treas., Div. of San. Eng., State Board of Health, Pierre, So. Dak.

Sept. 23-26—Fort Worth, Texas (*Texas Hotel*)
AMERICAN PUBLIC WORKS ASSN., (Public Works Congress), Robert D. Bugher, Asst. Director, 1313 E. 60th St., Chicago 37, Ill.

Sept. 26-27—Stillwater, Oklahoma (*Oklahoma A & M College*)
OKLAHOMA WATER, SEWAGE & INDUSTRIAL WASTES CONFERENCE, H. M. CRANE, Secy.-Treas., Okla. State Dept. of Health, 3400 North Eastern, Oklahoma City, Okla.

Sept. 26-28—LaCrosse, Wisconsin (*Stoddard Hotel*)
WISCONSIN SECTION, A.W.W.A. Harry Breimeister, Secy., Chief Utility Engr, City Engineers Office, City Hall, Milwaukee 2, Wis.

Sept. 30-Oct. 1, 2—Jefferson City, Missouri (*Hotel Governor*)
MISSOURI SECTION, A.W.W.A.,
(*Jointly With*)
MISSOURI WATER & SEWAGE CONFERENCE, Warren A. Kramer, Secy.-Treas., Division of Health, Jefferson City, Missouri.

Oct. 2-3—Springfield, Illinois (*Leland Hotel*)
ILLINOIS WATER PLANT OPERATORS' CONFERENCE Clarence W. Klassen, Chief San. Engr., State Dept. Public Health, Springfield, Ill.

Oct. 3-5—Mandan, No. Dakota (*Lewis & Clark Hotel*)
NORTH DAKOTA WATER & SEWAGE WORKS CONFERENCE, Jerome H. Svore, Secy.-Treas., % State Dept. of Health, Bismarck, N. Dakota.

Oct. 4-6—Boise, Idaho (*Hotel Boise*)
PACIFIC NORTHWEST SEWAGE & INDUSTRIAL WASTES ASSN., W. W. Saxton, Secy.-Treas., 408 Old Capitol Bldg., Olympia.

Oct. 8-11—Los Angeles, Calif. (*Hotel Statler*)
FEDERATION OF SEWAGE AND INDUSTRIAL WASTES ASSNS., Ralph E. Fuhrman, Exec. Secy., 4435 Wisconsin Ave., N.W., Washington 16, D. C.

Oct. 9-12—Atlantic City, N. J. (*Chalfonte Hotel*)
PENNSYLVANIA WATER WORKS ASSOCIATION, John H. Murdoch, Jr., Pres., American Water Works Service Co., 121 S. Broad St., Philadelphia 7, Pa.

Oct. 10—Caribou, Maine
MAINE WATER UTILITIES ASSOCIATION, Gerard F. Laurin, Secy.-Treas., 89 Western Avenue, Augusta, Maine.

Oct. 14-17—Little Rock, Arkansas (*Marion Hotel*)
SOUTHWEST SECTION, A.W.W.A., Secy., Leslie A. Jackson, Robinson Memorial Auditorium, Little Rock, Ark.

Oct. 15-16—St. John, New Brunswick (*Admiral Beatty Hotel*)
MARITIME BRANCH, CANADIAN SECTION, A.W.W.A., J. D. Kline, Secy.-Treas., Public Service Comm., P.O. Box 608, Halifax, N. S.

Oct. 15-17—Philadelphia, Pa. (*Drake Hotel*)
NATIONAL ASSOCIATION OF CORROSION ENGINEERS, NORTHEAST REGION, A. B. Campbell, Exec. Secy., 1061 M & M Bldg., Houston 2, Texas

Oct. 15-19—Pittsburgh, Pa. (*Wm. Penn Hotel*)
AMERICAN SOCIETY OF CIVIL ENGINEERS, Exec. Secy., W. H. Wisely, 33 W. 39th St., New York 18, N. Y.

Oct. 18-20—Atlantic City, N. J. (*Hotel Madison*)
NEW JERSEY SECTION, A.W.W.A., Secy., C. B. Tygert, Box 178, Newark 1, N. J.

Oct. 21-24—Mobile, Alabama (*BattleHouse*)
ALABAMA-MISSISSIPPI SECTION, A.W.W.A., Secy., Irving E. Anderson, Dist. Engr., Surface Water Branch, USGS, Box 2052, Jackson, Miss.

Oct. 22-24—Pittsburgh, Pa. (*Hotel William Penn*)
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA (17th Annual Water Conference) W. M. Porter, Secy., Hotel William Penn, Pittsburgh 30, Pa.

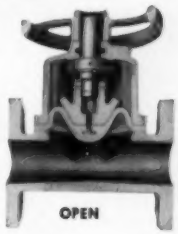
Oct. 23-26—San Diego, Calif. (*U.S. Grant Hotel*)
CALIFORNIA SECTION, A.W.W.A., H. J. Ongerth, Secy.-Treas., 2151 Berkeley Way, Berkeley, Calif.

(*Continued on page* 112*A*)

Flow Characteristics

similar to gate valves

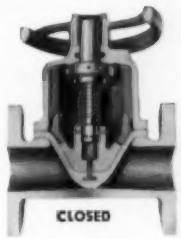
- Streamlined straight-through flow
- Minimum pressure drop
- Handles viscous materials without stoppage
- May be rodded or brushed



Advantages

of a diaphragm valve

- Positive closure even with gritty or fibrous materials
- No pockets to trap sludge
- Bonnet mechanism completely isolated from fluid in line
- Completely self-draining
- Simple maintenance



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For handling viscous materials, slurries, sludges, solids in suspension, sewage and corrosive chemicals, Grinnell now offers a valve which has all the advantages of a diaphragm valve with the added benefits of straight-through flow.

The Straightway Diaphragm Valve* is made in sizes from ½" to 8", screwed, flanged or butt weld ends, either handwheel or power operated.

A variety of body, lining, and diaphragm materials are available to meet practically all requirements. Descriptive folder gives all details.

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NATIONAL ASSOCIATION OF CORROSION ENGINEERS, SOUTH CENTRAL REGION, A. B. Campbell, Exec. Secy., 1061 M & M Bldg., Houston 2, Texas.

Oct. 24-26—Des Moines, Iowa (*Hotel Fort Des Moines*)
IOWA SECTION, A.W.W.A., Secy., J. J. Hail, Supt. of Water, City Hall, Dubuque, Iowa.

Oct. 24-26—Baltimore, Maryland (*Sheraton Belvedere*)
CHESAPEAKE SECTION, A.W.W.A., Secy., Carl J. Lauter, 6955 33rd Street, Washington 15, D. C.

Oct. 29-31—Windsor, Ontario (*Prince Edward Hotel*)
THE CANADIAN INSTITUTE ON SEWAGE & SANITATION, A. E. Berry, Secy.-Treas., Ontario Dept. of Health, Parliament Bldg., Toronto, Canada.

Oct. 31-Nov. 1-2—Bluefield, W. V. (*West Virginia Hotel*)
WEST VIRGINIA SECTION, A.W.W.A., Secy., Hugh W. Hetzer, Engr., W. Va., Water Service Co., Charleston, W. Va.
(*Jointly With*)
WEST VA. SEWAGE & IND. WASTES ASSN., G. O. Fortney, Secy.-Treas., State Health Dept., Charleston 5, W. Va.

Nov. 1-2—Omaha, Nebraska (*Castle Hotel*)
NEBRASKA SEWAGE & INDUSTRIAL WASTES ASSN., V. J. Lechtenberg, Secy.-Treas., 614 Standard Oil Bldg., Omaha, Neb.

Nov. 7-9—Old Point Comfort, Virginia (*Chamberlin Hotel*)
VIRGINIA SECTION, A.W.W.A., Secy., J. P. Kavanagh, 213 Carlton Terrace Bldg., Roanoke, Va.

Nov. 8—Greenfield, Mass. (*Hotel Weldon*)
NEW ENGLAND SEWAGE & INDUSTRIAL WASTES ASSN., Henry F. Munroe, Secy.-Treas., 75 Paine Ave., Cranston 10, R. I.

Nov. 11-14—Daytona Beach, Fla. (*Daytona Plaza Hotel*)
FLORIDA SECTION, A.W.W.A., Secy. Jay D. Roth, City Hall, Miami Beach 39, Fla.
(*Jointly With*)
FLORIDA SEWAGE & INDUSTRIAL WASTES ASSN., M. E. Dawkins, Secy.-Treas., % Reynolds, Smith & Hills, P.O. Box 4817, Jacksonville 1, Fla.

Nov. 12-14—Charlotte, N. C. (*Hotel Charlotte*)
NORTH CAROLINA SECTION, A.W.W.A.,
(*Jointly With*)
NORTH CAROLINA SEWAGE & INDUSTRIAL WASTES ASSN., W. E. Long, Jr., Secy.-Treas., Box 2091, Raleigh, N. C.

Nov. 12-16—Atlantic City, N. J. (*Convention Hall*)
AMERICAN PUBLIC HEALTH ASSN., Secy., Dr. Reginald M. Atwater, 1790 Broadway, New York, N. Y.

Nov. 15-16—Detroit, Michigan (*Hotel Statler*)
NATIONAL ASSOCIATION OF CORROSION ENGINEERS, NORTH CENTRAL REGION, A. B. Campbell, Exec. Secy., 1061 M & M Bldg., Houston 2, Texas.

Nov. 26-28—Colorado Springs, Colo. (*Broadmoor Hotel*)
ROCKY MOUNTAIN SECTION, A.W.W.A., Jack W. Davis, Secy., Johns-Manville Sales Inc., Denver, Colorado.

Dec. 3-7—Stillwater, Oklahoma (*Oklahoma A & M College*)
13TH ANNUAL OKLAHOMA WATER & SEWAGE SHORT COURSE. H. M. Crane, Secy.-Treas., Okla. State Dept. of Health, 3400 North Eastern, Oklahoma City, Okla.

Dec. 9-12—Boston Mass, (*Statler Hotel*)
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS Annual Meeting. F. J. Van Antwerpen, 25 W. 45th Street, New York 36, N. Y.

Dec. 12—Pittsfield, Maine
MAINE WATER UTILITIES ASSOCIATION, Gerard F. Laurin, Secy.-Treas., 89 Western Avenue, Augusta, Maine.

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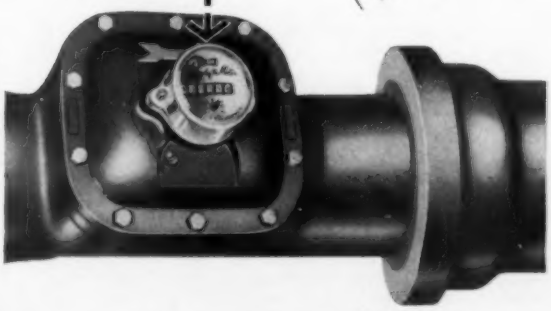

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helping to mix a good, clear drink for 5 years

The city of Denver has, for many years, been noted for the purity of its drinking water. Transported from the western slopes of the Rockies through the famous Moffat Tunnel, the water is purified in the Moffat Filter Plant of the Denver Municipal Water Works.

It is here that *flexible* U. S. Pilot Pipe plays an important role – carrying the chemicals that purify the water–maintaining what is known as a good P.H. factor. This U.S. Pilot Pipe installation has given completely trouble-free service since the day it was put in. That was back in 1950–over five years ago.

With ordinary piping, lime in the chemicals builds up and clogs the pipe. But because U. S. Pilot Pipe is flexible, lime is easily broken loose by merely *tapping or walking the pipe!*

"U. S." specializes in products to handle corrosive chemicals and acids. These problems usually can be solved by such "U. S." products as Pilot Pipe, Uscolite®, Tank Linings, and Permobond® protective rubber lining.

Contact our factory trained engineers at any of the 28 "U. S." District Sales Offices or write us at Rockefeller Center, New York 20, N. Y.

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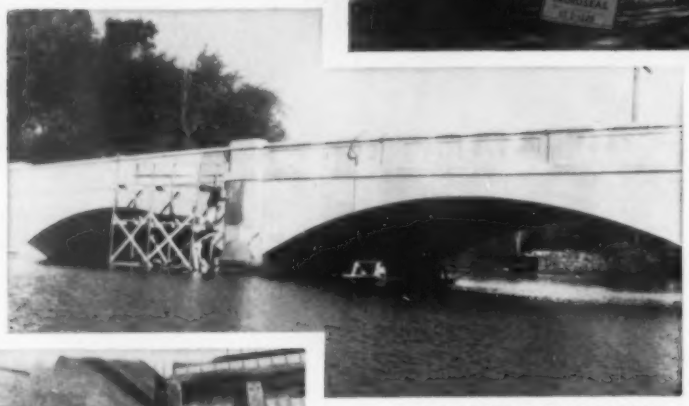
Mechanical Goods Division

United States Rubber

It's *New Again* with THORITE and THOROSEAL

Freeze-thaw cycle following water and moisture penetration, also swelling of reinforcing rods from moisture contact, cause masonry destruction.



BRIDGE OVER CONCORD RIVER
ROUTE 3, BELLERICA, MASS.

Workmen on scaffold patch spalled and cracked concrete with THORITE and seal surface with THOROSEAL.

Area at left chipped to sound masonry. It will then be patched with THORITE *Nonshrink, Nonslump 20-Minute Set Patching Mortar*, without necessity of costly forming, finished by application of Thoroseal.

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SPILLWAY

Rynders Chosen New Supt. of Milwaukee Water Works.

Arthur Rynders, former assistant city engineer, has been made superintendent of the Milwaukee Water Works, succeeding E. F. Tanghe, resigned.

The appointment of Rynders was made by Lloyd D. Knapp, commissioner of public works, under whom Rynders had served for a number of years as engineer in charge of water works construction in the City Engineer's Office. Before that he was in charge of plant design. He is 56 years old and has served the city of Milwaukee for 32 years.

Arthur Rynders is a graduate of the Univ. of Wisconsin (B.S. in mechanical engineering 1923) and in 1932 he earned the degree of M.S. in mechanical engineering. He served for three years in the navy's famed "Seabees" during World War II, is married and has two children and four grand children.

Rynders takes over as superintendent at a very important period of expansion of the Milwaukee Water Works, involving about $30,000,000 in planned improvements being evolved by Black & Veatch Engineers of Kansas City, Mo.

H. C. Boardman, C.B. & I.'s Director of Research, Dies

Harry Clow Boardman, Director of Research, Chicago Bridge & Iron Co. of Chicago, died on August 6th in Chicago.

Mr. Boardman, born in Plainfield, Ill., April 29th, 1887, was graduated from the University of Illinois in 1910. He also was holder of a C.E. degree from the Uni-

versity of Illinois and Doctor of Engineering degree from the South Dakota State School of Mines.

Entering the army as a private in 1916, he was discharged in 1919 as major of Field Artillary. Following the war he was in business in Kansas City and was an instructor at the University of Illinois. From 1910 to 1916 and since 1926 he has been with the Chicago Bridge & Iron Co.

Since 1954 Mr. Boardman has been Chairman of the Boiler and Pressure Vessel Code Committee of the American Society of Mechanical Engineers. He was a member of this committee for over twenty years and served on many of its important subcommittees. He served as president (1939) of the American Welding Society and Chairman (1950) of the Welding Research Council. He was active in the American Society of Civil Engineers, the American Petroleum Institute, the Western Society of Engineers, the American Society of Metals, the American Society for Testing Materials, the American Water Works Association and the American Association for Advancement of Science. He was also a member of Tau Beta Pi and Sigma Xi honorary engineering societies.

Jack Hinman is Dead

Jack J. Hinman Jr., a past-president of the American Water Works Association, passed away July 19 in Orleans, France, as a result of a heart attack. He was 67 years old.

Jack Hinman was born in Indianapolis, Ind., Oct. 18, 1888. He was a graduate of Butler College (A.B. 1911) and of the University of Iowa (M.S. 1915). His carreer began as director of the Iowa State Epedemiological Laboratory, Iowa City, Ia. During World War I he served in the Chemical Warfare

(*Continued on page* 116A)

SPEED WATER-SEWAGE WORK

with Bucyrus-Erie Hydrohoe and 6 Interchangeable Tools

WRIST-ACTION DIPPERS *are quickly interchangeable. Standard 18-in., shown above, narrow 12-in., or wide 24-in. cut precise trench you need . . . save time and expense by reducing amount of backfilling needed.*

The all-hydraulic Bucyrus-Erie Hydrohoe combines the speed and maneuverability of a conventional truck, the capacity and precision of hydraulic power and control, and the added versatility of six special tools to give you *the machine* best suited to water-sewage work.

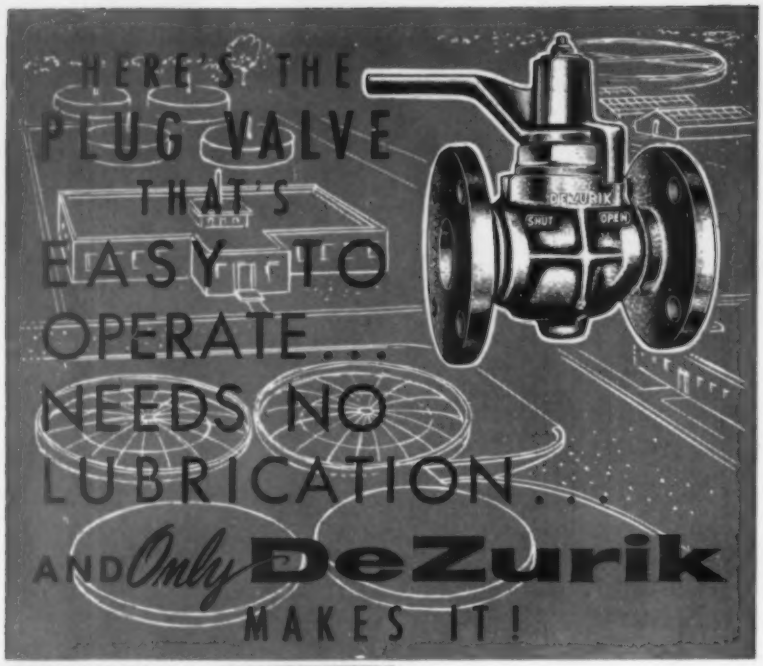
When you see it in action, you'll be convinced that the Hydrohoe is one machine designed to meet a great variety of water-sewage jobs. To arrange for a demonstration, contact your nearby Bucyrus-Erie distributor now. 158H56

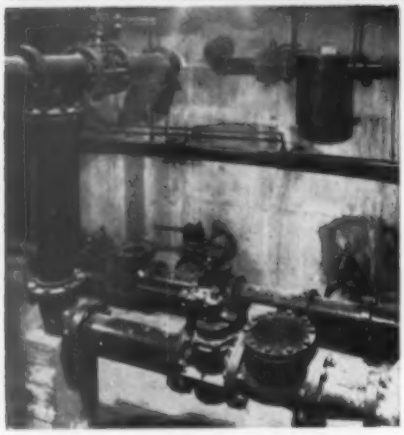
SPECIAL UTILITIES DIPPER, *20 inches wide, is designed especially for digging deep, short length holes. Rotating through an arc of 95°, this dipper permits undercutting sides, squaring corners . . . reduces hand trimming on manhole, catch basin, valve or repair excavations.*

DITCH CLEAN-OUT DIPPER, *60 inches wide, is reversible. With it, you clean drainage ditches quickly with normal hoe action. In reversed position, with loader action, you dump on opposite bank away from road and shoulder.*

COMBINED POWER UNIT AND AIR COMPRESSOR *mounted on the Hydrohoe gives you plenty of power for a variety of air tools without the usual transporting problems. This optional combined unit delivers 120 cfm against 100 psi.*

BUCYRUS ERIE South Milwaukee, Wisconsin

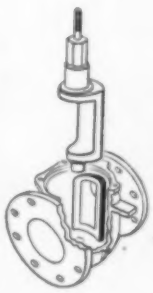




ON ALL LINES FROM HEAVY SLUDGE TO GAS, DeZURIK VALVES PERFORM WITH EQUAL EXCELLENCE. THEY OPEN OR CLOSE WITH AN E-A-S-Y QUARTER-TURN . . . . THEY NEED NO LUBRICATION . . . AND THEY DON'T LEAK!

Note the short operating levers on these 8" DeZurik Valves! DeZurik's exclusive eccentric principle accounts for this easy operation. The resilient plug-face contacts the seat only when the valve is closed, and it seals dead tight on any line despite solids in the flow. In opening the valve, the plug swings away from the seat so that the first fractional movement of the plug effectively eliminates all friction between the plug and the valve body—without binding or sticking, without lubrication!

DeZurik Valves are manufactured in a full range of sizes for operation on gas lines, sludge pump discharge, raw or digested sludges, raw sewage and many others.



Write for complete details. Representatives in all principal cities.

DeZURIK SHOWER CO.
Sartell, Minn.

Service as first lieutenant. He returned to the University of Iowa in 1929 as chief of the Water Laboratory Division of the State of Iowa. From 1921 to 1938 he was associate professor of sanitary engineering. During this time he pursued courses in civil engineering and in 1938 was awarded the C.E. degree by the University. As lieutenant colonel in World War II Professor Hinman served first in the Chemical Warfare Service and later in the Corps of Engineers. He was retired as a reserve officer in 1948 with the rank of full Colonel. The same year he also retired from the University of Iowa to enter the consulting field.

Jack Hinman served as chairman of important committees of the American Water Works Assn. In recognition of his services he was elected president of the Association. He produced numerous technical articles and was a member of every association of consequence in his chosen field. These included AWWA, ASCE, AIChE, APHA, FS&IWA, ACS, ASEE, and NSPE. He was a member of the honorary engineering fraternities Sigma Xi and Phi Lambda Upsilon.

Colonel Hinman is survived by his widow, a daughter and a son, Commander J. J. Hinman III. At the time of his death he was visiting his daughter, Mrs. Frances Dykstra, who lives in Orleans, France.

Paul Troemper Becomes Chief Engr. of Springfield Sanitary Distr.

A. Paul Troemper, former chief of the Bureau of Stream Pollution of the Illinois Sanitary Water Board, has been appointed chief engineer of The Sanitary District of Springfield, Ill. He succeeds the late W. B. Walraven.

Paul Troemper is a graduate (B.S. in Civil Engineering 1935) of the University of Illinois. He joined the Ill. State Dept. of

(*Continued on page* 118A)

Large Elevated Water Tanks Urged to Cut Shortage

Reserve Storage Needed

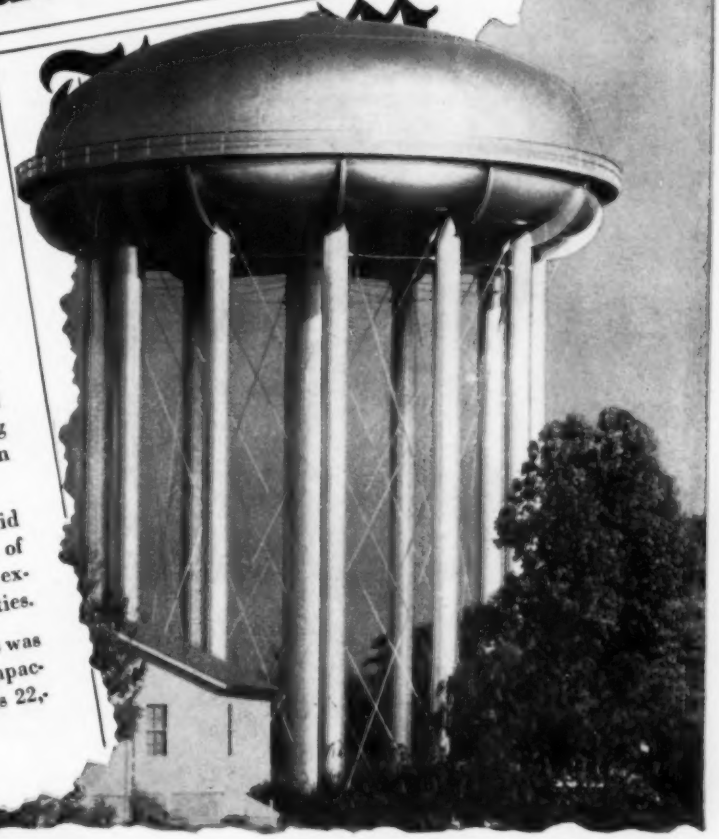
Engineer's Plan Bared

Plans were advanced here Friday for new 3,000,000 gallon elevated water storage tanks that could be used to ease the load at the two municipal water plants.

This city's consulting engineer told city officials the tanks could be filled during normal pumping conditions and put into use when water shortages occur.

The city's utilities director said water demands, caused by lack of sufficient rainfall, continued to exceed the plant's rated capacities.

A total of 26,050,000 gallons was pumped Thursday. Rated capacity of the pumping station is 22,000,000.



Horton Elevated Tanks are the answer to the need

Peak load periods of water demand, especially in the summertime with lawn and garden sprinkling, are dropping distribution pressures to dangerous levels in many cities, towns and suburbs throughout the country. If this is your community's problem, a Horton® elevated tank can solve it . . . by storing a reserve of water that flows by dependable gravity pressure to meet peak load periods, reduce pressure variations and increase pressures in the overall distribution system.

Horton elevated tanks with ellipsoidal-bottoms are built in standard capacities to 500,000 gallons. Radial-cone bottom elevated tanks are built in sizes from 500,000 to 3,000,000 gallons. Write our nearest office for further information, estimates or quotations.

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
New York • Philadelphia • Pittsburgh • Salt Lake City • San Francisco
Seattle • South Pasadena • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY *and* GREENVILLE, PA.

CBI

Above: 1,000,000-gal. Horton radial-cone bottom elevated tank built for Catonville, Maryland.

Health in 1935 and has served the Department and the Water Board continuously since but for World War II service as captain in The Sanitary Corps, U. S. Army, 1942-1946.

Troemper has served as secretary-treasurer of The Central States Sewage Works & Industrial Wastes Assn. and is presently 1st. Vice President of the Association. He is a member of the National and the Ill. Society of Professional Engineers, also the Ill. Public Health Assn. He represents Illinois on the sewage works standards committee of the Upper Mississippi-Great Lakes Board of public health enginers. He is also vice-chairman of the committee of The Federation of Sewage and Ind. Wastes Assoc. charged with the preparation of a Manual on Operation of Sewage Works.

Trustees of the Sanitary District of Springfield said that Paul Troemper was chosen for his broad background of experience in sanitary district work and knowledge of The Springfield District in particular.

Langdon Pearse is Dead

One of America's Pioneer Sanitary Engineers. Served Chicago's Sanitary Distr. for 47 years.

Langdon Pearse, internationally known sanitary engineer, died at his home in Winnetka, Ill., on July 20, 1956. He was 78 years old.

Mr. Pearse was born in Boston, Mass., Nov. 12, 1877. He held an A.B. degree from Howard College —(1899) and B.S. and M.S. degrees from Mass. Institute of Technology (1901-1902). He served as assistant engineer of water and sewage works at Columbus, Ohio (1904-1907) and as assistant engineer with The People's Water Co. of Oakland, Calif. (1907-1908). In 1909 he joined the Sanitary District of Chicago and in 1921 was made Sanitary Engineer of the District—now known as The Metropolitan Sanitary District of Greater Chicago. This position he held up to his death, rounding out 47 years of service with the District.

Mr. Pearse's assignment was that of developing improved and economic means of sewage and waste treatment in order to reduce the dilution water taken from Lake Michigan for disposal of Chicago's sewage. During his tenure much that was new was learned about sewage and industrial waste treatment. Based on data assembled from experimental work and pilot plant operations Chicago's several sewage treatment works (including the world's largest) were designed and placed in operation.

Langdon Pearse was a tireless worker and seeker of the hard truth in his chosen profession. In controversies he generally made his decisions and conclusions stick.

Langdon Pearse contributed much in his published articles and as chairman of a number of important committees. For ten years he was listened to intently in his

(*Continued on page* 120A)

FROM THE FILES OF DR. CENTRILINE...

CASE #1687

PATIENT:	5 miles of 62" and 36" steel water mains in St. Louis, Missouri.
SYMPTOMS:	Leakage repair costs on the increase from 1936 to 1947.
DIAGNOSIS:	External corrosion causing pitting through the pipe wall.
TREATMENT:	In 1947, after consultation with Centriline, pipelines were cleaned and cement-lined in place with a smooth, dense mortar lining by the Centriline Process.
RESULTS:	The dense cement lining stopped leakage, eliminating high maintenance costs. Savings represented 13% return on the cost of cleaning and lining.*

This lining has paid for itself in only 8 years. Not only was the leakage stopped but the carrying capacity was increased. If your problem is leakage in steel pipe . . . or capacity reducing tuberculation in steel or cast iron water mains, consider the advantages of cement lining in place.

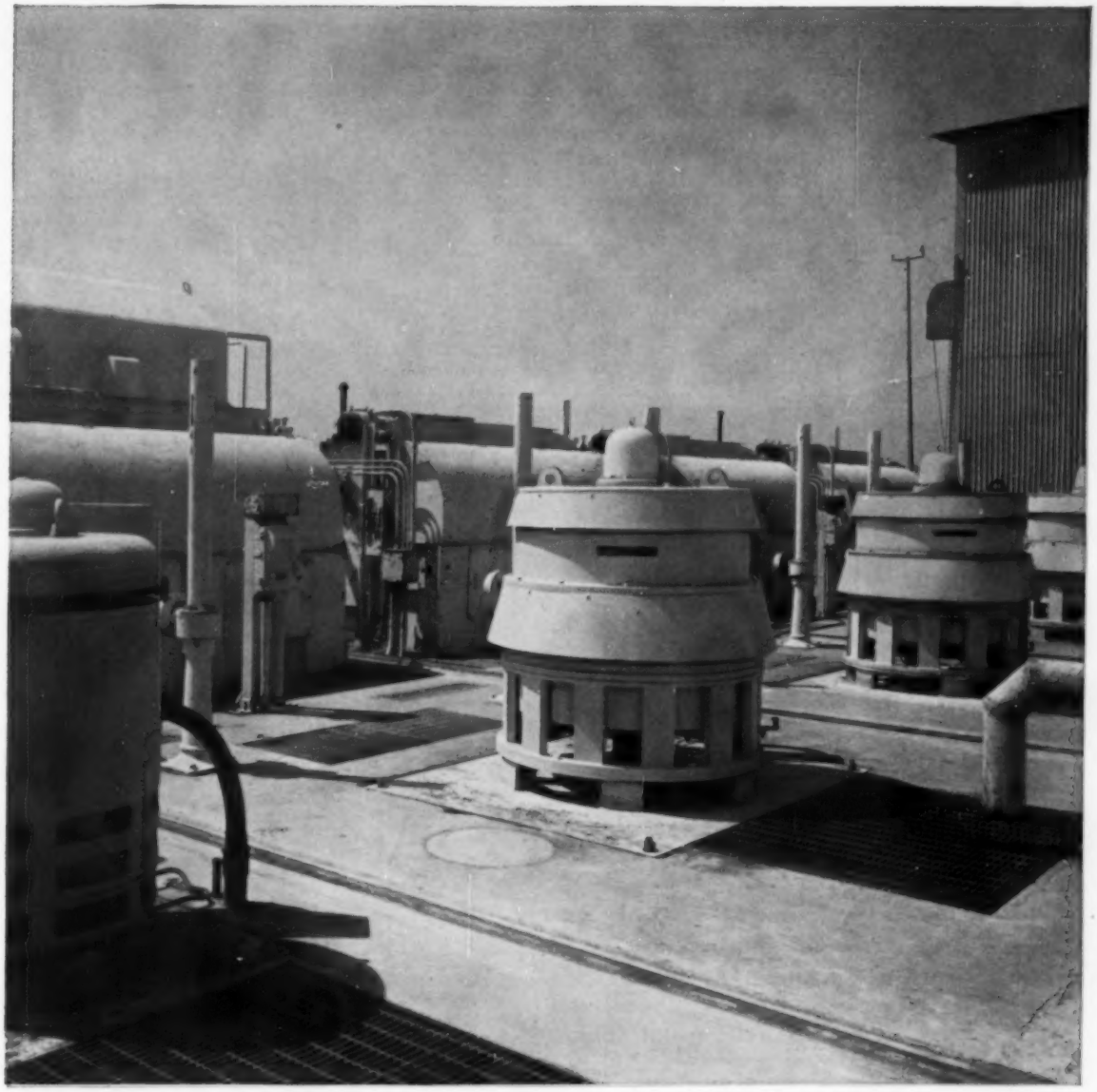
*From a paper written by Mr. John B. Dean, Division Engineer, Water Div., St. Louis, Mo.

CENTRILINE CORPORATION

A subsidiary of the Raymond Concrete Pile Company

140 Cedar Street, New York 6, N. Y.
WOrth 2-1429

Branch Offices in Principal Cities of the United States, Canada and Latin America



Four Fairbanks-Morse low-lift propeller pumps at Fairless

Delaware Borrow

Every day the Fairless Works takes 230 million gallons of water from the Delaware River, uses it in the production of iron and steel, and after treatment returns it to the river. The "big borrow" is started in a plant pumping station equipped with ten Fairbanks-Morse propeller and turbine pumps in efficiently chosen sizes up to 48 inches.

There are pumps in the Fairbanks-Morse line to move any magnitude of industrial water supply at any appropriate pressure, and other pumps to meet ordinary or unusual problems of industrial wastes treatment and disposal. A Fairbanks-Morse hydraulics engineer will be happy to work with your engineers or consultants in specifying the right pump for your specific job. Fairbanks, Morse & Co., Dept. WSW-9, 600 South Michigan Avenue, Chicago 5, Illinois.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

PUMPS · SCALES · DIESEL LOCOMOTIVES AND ENGINES · ELECTRICAL MACHINERY · RAIL CARS · HOME WATER SERVICE EQUIPMENT · MOWERS · MAGNETOS

biennial reports as chairman of A.S.C.E.'s Committee on Sewage Treatment. For twenty years he was chairman of A.P.H.A.'s Committee on Sewage Treatment. He was amongst the stalwarts that founded the American Federation of Sewage Works Associations and was a member of every professional engineering association and water and sewage works association of consequence. He was Phi Beta Kappa, a member of the American Academy of Arts & Sciences and member of the Engineering Institutes of Great Britain and Canada. He was a member of Chicago's University Club and the exclusive Indian Hills Club of Winnetka. He is survived by his charming widow, also a native Bostonian, whom he married in 1910.

All in all, Mr. Pearse was quite a fellow—straight from the shoulder; and win, lose, or draw, was always the same Langdon Pearse. We will miss him.

Fred S. Gibbs Inc. Still in Business

Fred S. Gibbs Inc. of Newton Lower Falls, Mass. is still in business marketing The Gibbs Flotation Process for treating industrial wastes and sewage.

In our July 1956 issue appeared an announcement that Fred S. Gibbs, a native New York, had joined the firm Smith-Blair Inc. of South San Francisco, Calif.

As the result of this announcement Fred Gibbs, president of Fred S. Gibbs Inc. received many letters wanting to know what had happened to Fred S. Gibbs Inc. As Mr. Gibbs remarks "The power of your press appears to be overwhelming" as judged from the mail received as the result of the July item.

The confusion results from the fact that Fred S. Gibbs of Fred S. Gibbs Inc. is also a "native New Yorker". Beyond that there is no relationship between the two Fred S. Gibbs, and Fred S. Gibbs Inc. is still in business at Lower Newton Falls, Mass.

Sol Seid Appointed Chief Engr. Middlesex Sewerage Authority

Sol Seid, Supervisor of Public Works, New Brunswick, N. J., has been appointed chief engineer of the Sewerage Authority of Middlesex County, N. J.

Mr. Seid is a graduate of Rutgers University (1936) and holder of a professional engineer's certificate in the State of New Jersey. He is a past-president of the N. J. Sewage & Industrial Wastes Assn., and former director of The Federation of Sewage & Industrial Water Associations. He is a member of the State Board of Examiners for Water and Sewage Works Operator's Licenses. Amongst the professional societies he is a member of the following A.P.W.A., N.S.P.E., A.A.A.S., N.J.S.&I.W.A.

Mr. Seid is serving as consultant to several smaller municipalities on sewage treatment and some industries on industrial waste treatment. He will continue on a part time basis as a supervisor of Public Works and consultant on sewage disposal for New Brunswick, N. J.

by PRELOAD
TRADE MARK

City of Philadelphia, Penna. North East Sewage Disposal Plant. Eight 110'6" inside diameter x 32' high Digesters.

- Economical First Cost
- Maintenance Free
- Long Life Expectancy
- Architecturally Pleasing
- Big Jobs . . . Small Jobs

If you are planning for Sludge Digestion Tanks, be sure to check on Prestressed Concrete Digesters. Today's most modern installations take advantage of many economies offered by Prestressed Concrete design.

Send for Bulletin T-7 on SLUDGE DIGESTION TANKS

INTERESTED IN WATER TANKS? Send for Bulletin T-12

THE PRELOAD COMPANY, INC.
211 East 37th Street, New York, N. Y.

PRELOAD CONCRETE STRUCTURES INC.
93 North Grand Avenue
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P. O. Box 652
Bayshore Annex
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THE PRELOAD COMPANY, INC.
(Southwest District Office)
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Why settle for less?

With Pennsalt liquid chlorine you avoid impurities which cause equipment trouble

You needn't accept less than the highest-purity chlorine in trouble-free cylinders. At no extra cost, you can have Pennsalt Chlorine, which is taken through an extra fractionating column and bottled *by the manufacturer*. Pennsalt has provided thirty years' uninterrupted cylinder service to chlorine users, even through wars and cyclical chlorine shortages.

To assure you maximum purity and safety, Pennsalt puts all chlorine cylinders through rigid inspection and reconditioning on each trip back home: Valves are dismantled, remachined if not up to Pennsalt standards, repacked, and then tested for leaks at 500 psi. After refilling, cylinders are given two final tests for leaks and workability at intervals of 24 hours or more.

Call your nearby Pennsalt district office for a technical bulletin on Pennsalt Liquid Chlorine, or write Industrial Chemicals Division 306, Pennsylvania Salt Manufacturing Company, Three Penn Center Plaza, Philadelphia 2, Pa.

Other Pennsalt Chemicals for water and sewage treatment:

Anhydrous Ferric Chloride, Liquid Ferric Chloride, Alum, Per*chloron*® (high-test calcium hypochlorite).

Pennsalt Chemicals

PENNSALT DISTRICT OFFICES

Appleton, Wisconsin
Chicago 1, Illinois
Cincinnati 2, Ohio
Cleveland 2, Ohio
Decatur, Georgia
Detroit 26, Michigan
Paterson 1, New Jersey
Philadelphia 2, Pennsylvania
Pittsburgh 19, Pennsylvania
St. Louis 1, Missouri
Tacoma 2, Washington

Exacting care, from the moment of manufacture until delivery, assures you not only the high purity you expect of Pennsalt Chlorine but also freedom from vexing and hazardous mechanical difficulties.

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

W&SW

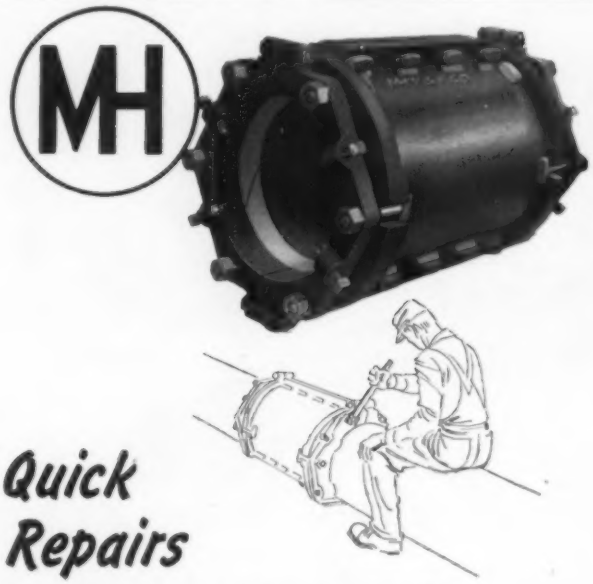
New Equipment

Combination Drive For Continuous Pumping

901

U. S. Electrical Motors Inc., Los Angeles, Calif., has developed a new right-angle combination drive for municipal water supply stations, sewage disposal plants, fire fighting stations and other installations where continuous or stand-by pumping service is essential. Identified as the U. S. Holloshaft, Type GPC, sizes range from 30 to 150 H.P. and are available in a wide selection of gear ratios.

In normal operation, an electric motor, mounted on the dis-engaged drive, powers the pump. In the event of a power failure or electric motor breakdown, the drive is then quickly and easily engaged to transmit power from a stand-by combustion engine with very little lost time under emergency conditions.



For Quick Repairs Use Mechanical Joint

M&H REPAIR SLEEVES

This sleeve makes a quick, permanent repair to a cracked or damaged main. It is easy to install – a good item to keep in stock for emergency use.

Supplied with the sleeve are split end-gaskets, split glands or follower rings, and longitudinal gaskets. Installation consists simply of placing the two halves of the sleeve and accessories around a broken pipe and bolting tight the joints. The longitudinal gaskets of the sleeve fit against the end gaskets, making a water-tight rubber seal. End gaskets are supplied to fit Classes AB or CD pit cast pipe, or Classes 100, 150, 200 and 250 centrifugally cast pipe. Available in sizes 4-inch to 16-inch.

M&H VALVE AND FITTINGS COMPANY, ANNISTON, ALABAMA

M&H PRODUCTS FOR WATER WORKS • FILTER PLANTS INDUSTRY • SEWAGE DISPOSAL AND FIRE PROTECTION

Pipeline Joint Wrap

902

L.O.F. Glass Fibers Company, Toledo, Ohio, has introduced a new pipeline joint wrap with almost double the tensile strength of the former product.

Known as "Duratape," the joint wrap is a parallel-reinforced glass fiber mat, heavily coated on both sides with plasticized coal tar. It is designed for hand wrapping of field joints and fittings to form a long-lasting, tough barrier against corrosion.

The tensile strength has been upped from 29 pounds per inch to an average of 55 pounds per inch of width. Field tests indicate that the product is adequate for any application regardless of how rough the treatment.

Remote Level Record Of Six Reservoirs

903

The Foxboro Co., Foxboro, Mass., has developed the Multi-Record Teletax Recorder that records the level of as many as six separate reservoirs on one circular chart.

Level intelligence is transmitted to the recorder over wire or microwave system by Teletax Telemeter Transmitters, one at each reservoir. The recorder receives one signal every 60 seconds so that consecutive measurements of any one reservoir are logged at six-minute intervals. On a seven-day chart, the separate dots become continuous records, each in a distinctive color ink.

Where telephone lines are used for the transmission of d-c level signals, a pair of lines is needed for

each reservoir in the network. If audio frequency equipment is used, one pair of lines will accommodate all the reservoirs. Pumps and valves can be operated remotely over the same transmission system in automatic response to changes in reservoir level.

Plastic Expansion-Joint Waterstop

904

Progress Unlimited Inc., New York, N. Y., has just introduced Plasti-Grip a 3-in-1 joint, made of extruded plastic (poly-vinyl-chloride) that can be used as an expansion joint, as a construction joint or as a waterstop. It comes in continuous strips 100 feet long and 5" or 6" wide. It can be cut with a knife and spliced on the job with a hot iron in minutes.

Plasti-Grip's deep grooves grip far better into the concrete than flat or dumbbell type joints and its exclusive reinforced "U" shaped center pleat expands and contracts with the joint. It is designed to give the most effective joint between two pours of concrete.

Plasti-Grip will resist waterpressures up to 125 feet head, stays flexible even in extreme low temperatures, is alkali and acid resistant, has virtually unlimited life and installed costs less than any other joint of comparable performance.

Ditcher Has Push Button Conveyor Shift

905

Garwood Industries, Inc., Wayne, Mich., has developed a highly manueverable ditcher that is equipped with a push button conveyor shift—a feature that allows the discharge conveyor to be instantly shifted to the opposite side of the ditcher in order to avoid trees, utility poles and other obstructions that ordinarily slow up ditching in close quarter residential work.

In Pasco, Washington, too— Clevelands® do the digging

DISTRIBUTION SYSTEMS in Pasco and Kenewick, Washington, are being constructed for Cascade Natural Gas Company by A. J. Curtis Construction Company of Casper, Wyoming. Even in alleys and similar narrow rights of way, such as the 4-inch main installation shown, Curtis, cashing in on the compactness and maneuverability of his Cleveland trenchers, is averaging 1,650 feet of trench per 6-hour day.

Crowded cramped quarters or open fields, rocky soils or easy digging—Cleveland's original compactness, maneuverability, exclusive wide range of power and speed combinations and recognized quality construction are the reasons they dig *more trench . . . in more places . . . at less cost.* That's why you'll find Clevelands leading the way on gas work in the Pacific Northwest —as they have *everywhere* for over 30 years.

THE CLEVELAND TRENCHER CO.

20100 ST. CLAIR AVENUE • CLEVELAND 17, OHIO

Good Everywhere

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

Compact Light-Weight Diesel Engines

906

R. H. Sheppard Co., Hanover, Pa., has introduced two new compact, light-weight diesel engines.

The Model 17A, 20 H.P., comparable in size, weight and price to 20 H. P. gasoline engines, was designed expressly to make possible use of diesel power in many applications where high initial cost, excessive weight and cumbersome size made it impractical before.

The Model 19, 42 H.P., is said to occupy less space than gasoline engines of comparable ratings. Intended primarily as replacement power where service conditions are too rugged for gasoline engines, it is easily installed without alterations to driven machines. The simplified fuel injection system makes it possible to service the system in the field without special tools or equipment, and by ordinary mechanics.

Hammer Grinder For Dry Sewage & Industrial Wastes

907

The Duplex Mill & Manufacturing Co., Springfield, Ohio, has announced the availability of the new Kelly Duplex Industrial Hammer Grinder for reducing and pulverizing all types of dry industrial and sewage wastes.

All grinding is done in mid-air. Swinging hammers, made of special abrasion resistant alloy steel, repeatedly strike the material while it is in a state of suspension and then pass it through a heavy steel screen, which is perforated to the desired degree of fineness.

Arc welded steel construction is used throughout, and the body is made of extra heavy steel plate mounted on a structural steel base. Self-aligning ball bearings are used exclusively and all working parts are made of special abrasion resistant materials. Hammers can be reversed for longer life and screens can be changed in less than 30 seconds without removing the mill cover.

E. R. P. CATHODIC PROTECTION ...
INDIVIDUALLY DESIGNED FOR EACH APPLICATION

An effective installation that operates at the lowest cost per year requires experienced engineering evaluation of site and environmental conditions. The Electro Rust-Proofing Engineering Division makes available to you the cumulative experience gained in designing more than 10,000 cathodic protection systems.

Electro Rust-Proofing can furnish any one, or all, of the following services to help you provide proper cathodic protection for each of your jobs:

- Corrosion surveys and recommendations
- Design based on engineering experience
- Cathodic protection equipment and installation
- Service to assure proper operating results

For additional information write today.

ERP CATHODIC PROTECTION SINCE 1935

ELECTRO RUST-PROOFING CORPORATION
30 MAIN STREET, BELLEVILLE 9, N. J.

E-35

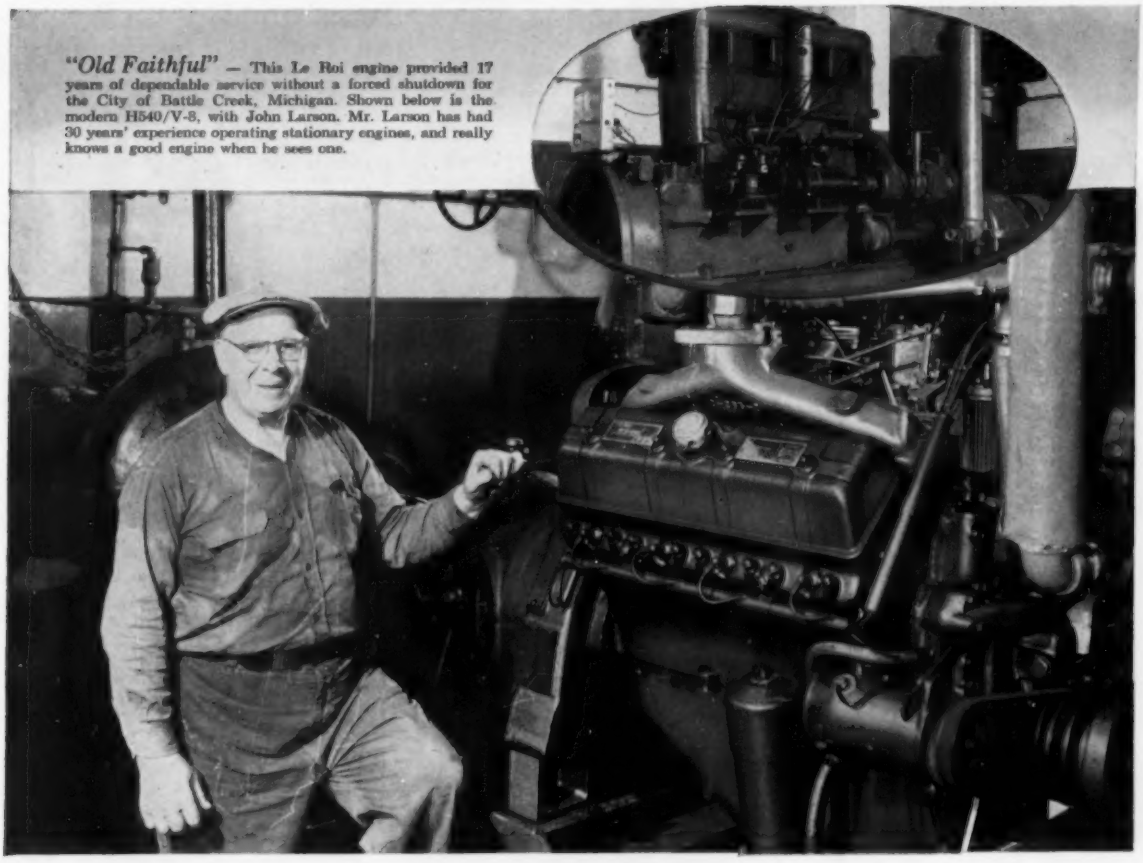
Pneumatic Tired Ditch Roller

908

John R. Cook, Augusta, Ga., has developed a pneumatic tired ditch roller that attaches to Caterpillar patrols, models 212, 112 and 12.

The roller was especially developed for tamping lengthy water or sewage main installations. The roller bears 1650 lbs. on the two tires while rolling. The cable for raising and lowering the roller into the ditch is worked from two drums that replace the scarafier. The leveling blade at the front of the roller is adjustable in that it can be lowered as the ditch is filled and can be leaned back or forward to keep it level regardless of the depth the roller is in the ditch. This leveling blade can also be turned to either the left or right, depending on which side the dirt is being pulled in from.

It is effective up to a depth of six feet and is designed to work behind wheel or ladder type ditchers cutting up to 24-inch trenches.



"Old Faithful" — This Le Roi engine provided 17 years of dependable service without a forced shutdown for the City of Battle Creek, Michigan. Shown below is the modern H540/V-8, with John Larson. Mr. Larson has had 30 years' experience operating stationary engines, and really knows a good engine when he sees one.

122,105.6 hours logged with only four overhauls

...dependable performance like this proves the value of Le Roi engines

In 1937, the City of Battle Creek installed its first Le Roi engine. Seventeen years later, when it was time to modernize, this engine had piled up the amazing total of hours shown above.

This is just one more example of Le Roi dependability. It is also proof of the excellent maintenance work performed by John Larson and his staff.

In 1954, "Old Faithful" was replaced by Le Roi's H540, a modern short-stroke V-8. The H540 normally operates at 1500 rpm, but, because of its short stroke V-8 design, piston speed is no greater than that of longer stroke, slower speed engines.

Moreover, the H540 provides new flexibility. This flexibility really paid off during flood conditions when the electric pumps were shorted out. The H540 ran up to 2100 rpm and, by so doing, carried the entire plant load for several days.

Performance during this emergency clearly indicated the advantages of the H540's short-stroke V-8 design. It proved that you get more horsepower per dollar and more horsepower per space. Other plus factors are easier servicing and easier installation.

Whether it's for continuous or standby service, or for pumps, blowers, or generators, it pays to use Le Roi engines. Le Roi power is dependable, low-cost power — power that can help ease the tax load in your community. You can get it in sizes ranging to 645 hp., or in custom generator sets from 50 to 350 KW. Write us for detailed information.

E-103

LE ROI *Division of Westinghouse Air Brake Co.*

Milwaukee 1, Wisconsin

PORTABLE AIR COMPRESSORS · TRACTAIR · STATIONARY AIR COMPRESSORS · AIR TOOLS · ENGINES

Curb Box Charger

909

Basil Miller, Elkhorn, Wisconsin, has available the Miller Curb Box Charger.

The charger is a device that contains a powerful Alnico magnet that will impart a magnetic charge to any piece of iron that is within range of its magnetic effect. It is made long and slender so that it projects its magnetic charge deep into the earth and when it comes within range of a curb box the lines of magnetic force link up with those of the curb box and greatly intensify the magnetism of the curb box.

In using the charger on new work, the handle is shoved down and the charger is tapped on the top of the curb box, the handle is then pulled all the way back up and the job is done. The company states that the charge lasts indefinitely and re-magnetizing is not necessary.

Vertical, Hollow-Shaft Motors

910

General Electric Company, San Jose, Calif., has announced a completely new line of vertical, hollow-shaft motors in 7½ through 30 horsepower.

Designed for water-pumping applications, the new motors are the first of this kind carrying the company's Tri-Clad 55 name. They incorporate outstanding features of the new Tri-Clad horizontal motors, introduced in 1954, and of larger size vertical motors which were redesigned early in 1955.

Offering long-term reliability, improved performance and reduced maintenance, the new vertical motors were developed to meet specific needs of the user.

An exterior feature of the new design is a quick-look gage near the top of the unit which permits at-a-glance checking of the oil level. Development of the "Vistamatic" lubrication center, which includes the sight gage, is also featured by an extra large oil reservoir with an oil supply adequate for long-term bearing lubrication.

Test Meter For Operations Control Systems

911

Hammarlund Manufacturing Co., Inc., New York, N. Y., has developed a Test Meter for use with the Hammarlund Centralized Operations Control system. The new meter permits fast, simple testing without need of technical, trained personnel.

The attachment cable terminates in a plug-in connector that mates with sockets provided in every unit of COC equipment. Simple instructions contained in plastic laminated chart attached to the instrument provide a step-by-step procedure to be followed. All tests may be conducted without changing test leads or interrupting service. Control knobs are used to set up the instrument for the various tests involved.

"Out of sight—out of mind" can be a mighty expensive philosophy in any water distribution system. The above unretouched photograph proves this point. It shows a badly tuberculated *eight inch* main whose *inside diameter was reduced to an average of almost 4.5 inches.* Resultant higher pumping costs with reduced pressure and carrying capacity make it costly to tolerate such conditions. That is why the savings effected in reduced pumping costs frequently pay for the *low cost* of National water main cleaning.

Since there's never a charge or obligation to inspect your mains, *call National now!*

Call in National today!

NATIONAL WATER MAIN CLEANING COMPANY

50 Church Street • New York, N. Y.

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New, Versatile Hydraulic Shovel

912

Geco, Inc., Denver, Colo., has obtained manufacturing and sales rights for the U.S., Central and South America, of the Yumbo, a versatile hydraulic shovel featuring a precision-built ball bearing turntable and heavy duty hydraulic system.

The Yumbo is an all purpose tool with the following attachments: ¼ yd. backhoe, ⅝ yd. front dump bucket, ⅜ yd. rock bucket, ⅝ yd. gravel bucket, ½ yd. clamshell, and 6500 pound crane hook. One man can make a change of attachments in ten minutes without any hard labor. The backhoe has a digging depth of 10 ft. and a clear dumping height of 10 ft. The shovel also has a dumping height of 10 ft.

Septic Tank Cleaner

913

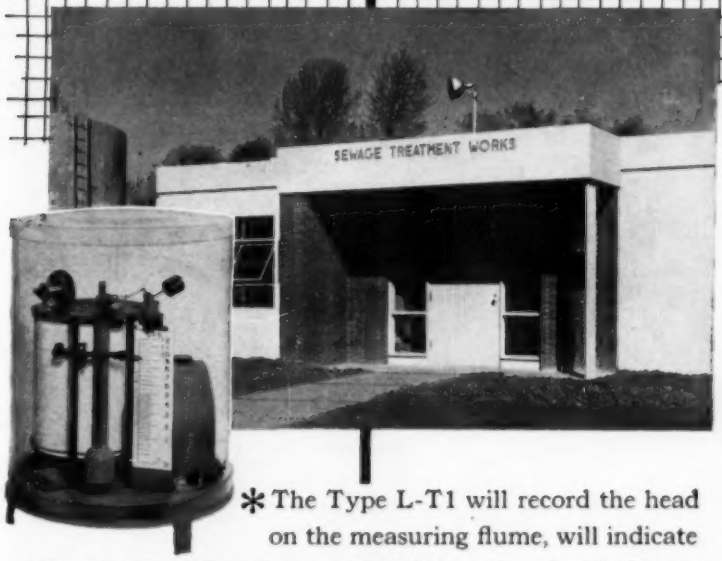
Lewis Research Labs. Inc., New York, New York, announce their New-Formula Septi-Kleen, developed to solve septic tank sanitation problems safely, surely and simply.

Laboratory-tested Septic-Kleen absorbs all sewage material, including tough cellulose products "by bacteria" . . . contains no harsh chemicals. Septi-Kleen liquifies, absorbs, reduces bulk, eliminates nasty odors, yet can't harm plumbing, people, or livestock.

Septi-Kleen keeps pipe lines and traps free from clogging and stoppage, eliminates the need for frequent cleanings, pumping, digging or moving.

PROBLEM:
To obtain at minimum cost the essential information on flow required for efficient operation of a small sewage treatment plant.

SOLUTION:
Stevens Type L-T1 Recorder*



* The Type L-T1 will record the head on the measuring flume, will indicate the volume of flow for any time interval and will give an instantaneous reading of the rate of flow. The head record, made on convenient rectangular coordinates, is basic information for permanent record from which plant operators and State Sanitary Engineers can check flows and volumes. The volume reading from the totalizer dials and the rate of flow indicator are essential for intelligent operation. Readings can be made in any desired volume and flow units.

STEVENS DATA BOOK

...invaluable for your reference file
144 pages of technical data on recorder installations... plus a wealth of hydraulic tables and conversion tables. **Send $1.00 (No C.O.D.'s)**

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One-Piece Pressure Seal

914

Precision Rubber Products Corp., Dayton, Ohio, has developed a one-piece pressure seal that promises to be the answer to leakage problems created by face-to-face sealing.

Called the Dyna-seal, the new sealing device is particularly adaptable to sealing under bolt heads, abutment flanges such as the pipe union, or similar flanges which require sealing between two faces with the bore open to pressure.

The seal consists of an inner sealing member made of Hycar American rubber, heat and pressure bonded to an outer confining cadmium plated steel ring or washer. The device supplies a positive lock washer action and effectively seals pressure up to 10,000 psi against air, water, all types of petroleum products, and many industrial gases and chemicals. The seals function in a temperature service range from −65°F to +250°F.

Shawnee Backhoe Digs 14 Feet Deep

915

The Shawnee Manufacturing Company, Inc., Topeka, Kansas has perfected and placed on the market its new "Chief". Designated model number D90, the new backhoe digs effectively at the 14 foot level, but its actual reach below the ground surface is 15 feet. In addition to its extreme digging depth, the "Chief" offers exceptional power by synchronizing the action of a push cylinder at one end of the bucket boom axis with another pull cylinder midway between the axis and the bucket. The company refers to this action as Push-Pull-Power. Utilizing the two synchronized cylinders relieves strain on the axis and increases digging pressure.

New Pipe Joint Tape For Field Wrapping

916

L.O.F. Glass Fibers Company, Toledo, Ohio, has introduced a new coated tape for field wrapping of joints and fittings on underground pipe lines which is comparable to the coating used in the overall wrapping operation.

The company had been offering a product called Duratape, which is a glass fiber mat coated on both surfaces. Previously, however, Duratape was coated only with coal tar. The new product coating is asphalt, thus L.O.F Glass Fibers can provide either coating to conform to the coating applied on the main body of the pipe. The company is also prepared to service requests for complete pipe line protection, including Blue Flag reinforcing wrap and Duramat outer wrap.

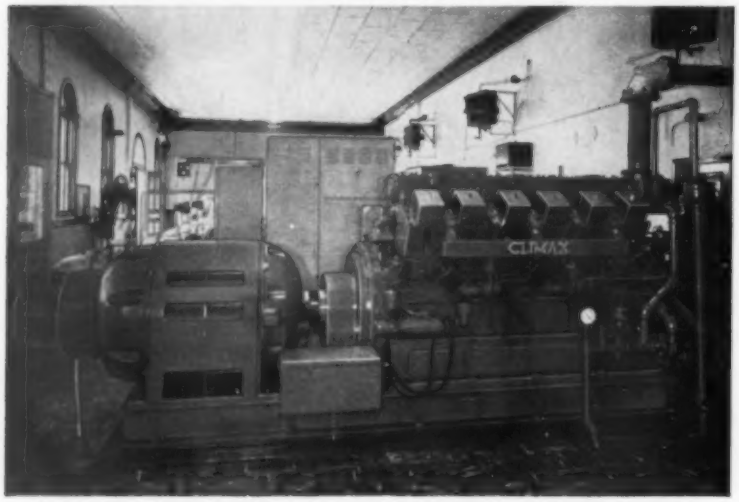
High-Head Differential Meters Transmit Linear Flow Signals

917

Bailey Meter Co., Cleveland, Ohio, has developed a new line of high-head differential pressure transmitters that permits high pressure—high velocity flows to be measured and transmitted pneumatically on a linear flow basis.

The new line of meters utilizing the accuracy of mercury U-tube measurements, automatically converts a differential pressure to rate of flow. Features are low cost, accuracy, rangeability, simplicity and flexibility.

These transmitters measure the rate of flow of steam, water, other liquids, and gases producing maximum differentials from 100 to 1200 in. H_2O. The mercury U-tube is available for maximum service pressures of 800, 3500, and 6000 psig. Where mercury is undesirable, a bellows type is available for maximum service pressure of 1500 and 3500 psig.



CLIMAX . . . EXTRA POWER RELIABILITY

A Climax Engine driven generator protects the Tonawanda, New York Water Works during any emergencies.

This Water Works was recently completely electrified, with motor driven pumps replacing old steam driven pumps. To provide sufficient KVA capacity to start large motors a 625 KVA generator is required. It is driven by a Climax Model V-125, 605 HP engine which has ample capacity to furnish the KVA required for starting and the KW required after the motors are under full load.

The consulting engineer for the project was Metcalf & Eddy of Boston.

climax

FOR COMPLETE INFORMATION, WRITE TO . . .

ENGINE AND PUMP MFG. CO.

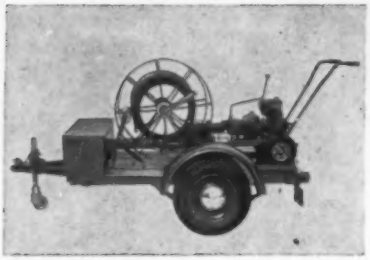
208 So. La Salle St.

CHICAGO 4, ILLINOIS

Factory—Clinton, Ia. *District Office*—Dallas, Tex.

Gasoline-Powered Storm And Sanitary Sewer Cleaner

918



The Ohio Tool and Engineering Co., Springfield, Ohio, has announced a new gasoline-powered Model No. 200 Electric Eel that has been especially designed for "on-the-job" threading and cleaning of storm and sanitary sewers. It can easily be moved to any location, and its self-contained power source make it ready for use anywhere. One man can operate the machine with complete safety, and quickly open the worst stoppages.

The power unit is mounted on a sturdy pneumatic-tired cart, and features a Clinton 2 H.P. 4-cycle back-geared engine with a foot-operated clutch for instantaneous control of cable rotation. Power is controlled through a Warner gear transmission, which provides three speeds forward and one reverse speed.

New, Larger, "Payloader"

919

The Frank G. Hough Co., Libertyville, Ill., has announced a larger model "HO" Payloader" tractor-shovel with numerous new features.

The new unit has a heaped capacity of 2¼ cubic yards and a struck capacity of 1¾ cubic yards. In addition to a complete "no-stop" power-shift transmission and torque converter, these units are equipped with planetary axles and torque-proportioning differentials.

Being introduced to the tractor-shovel field for the first time, the "torque-proportioning differential" combats wheel slipping. This feature adds greatly to the overall effectiveness of four-wheel-drive. When the wheel on one side encounters poor tractive conditions and tends to slip, the torque-proportioning differential automatically delivers more power to the opposite wheel.

Meet AWWA Specifications* for Tight Closure

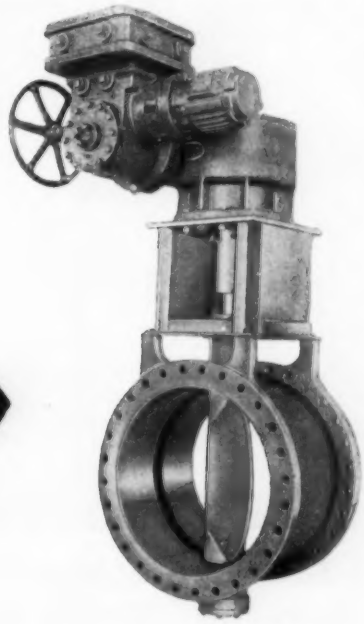
at Maximum Shut-off Pressures of 25, 50 and 125 psi

with your choice of

W. S. ROCKWELL

Flanged-End

BUTTERFLY VALVES



Rubber-Seated

Rubber-Lined

Both types in all sizes to 72". Manual operators – gear reducer with hand wheel or chain wheel; automatic operators–electric, hydraulic or pneumatic; for safe seating and unseating of valve disc at water velocity of 8 and 16 f.p.s.

A standard line of valves in sizes to 144" is available for other industrial, municipal and utilities requirements for tight shut-off or regulation of fluid flow. Write for Catalog.

*AWWA C-504-55T

ROCKWELL SINCE 1888 BUILT

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Sales Representatives in Principal Cities

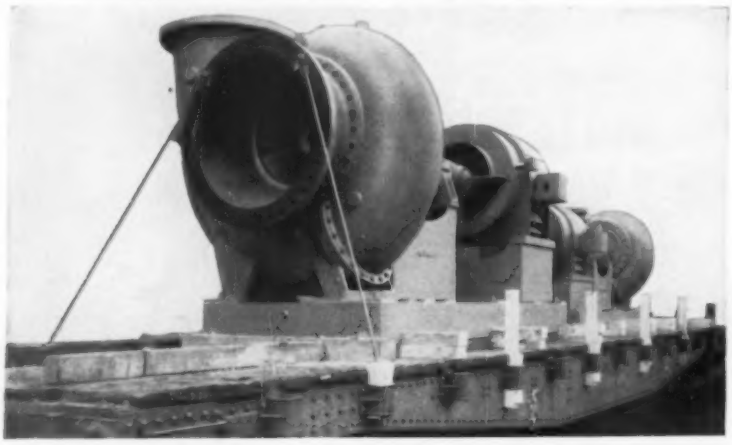
W&SW

Manufacturers' News

Neptune Names Doucet To Water Meter Sales Staff

Neptune Meter Co., New York, N. Y. has announced that Joseph Doucet of Burlingame, Calif., has been named a sales representative of the Company working out of the San Francisco office. Mr. Doucet will be in charge of the sale of water meters to municipal and private utilities in central California for use on residential, industrial, and commercial installations.

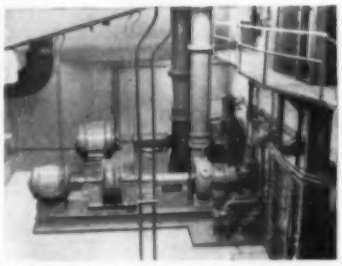
Mr. Doucet was born in Opelousas, La., attended Port Barre High School in Port Barre, Calif., and City College in San Francisco. He served in the navy from 1950 to 1954 and was awarded the Korean Battle Ribbon with Four Stars for service during the Korean War.



THESE WHEELER-ECONOMY PUMPS HOLD CONSTANT LEVELS IN THE NEW TRICKLING FILTERS AT DALLAS' WHITE ROCK PLANT

Two of the Wheeler-Economy pumps installed in the White Rock Sewage Treatment Plant for Dallas, Texas are believed to be the largest ever operated through magnetic couplings. In order to maintain constant levels in the suction wells and grit channels, each of the two units driven through magnetic couplings are governed by an elaborate float level control. This helps the big Wheeler-Economy pumps to maintain level within predetermined 6" limitations. Total pumping capacity of the four Wheeler-Economy pumps installed at the White Rock Plant is 134 million gallons a day.

Rely on Wheeler-Economy for help in complex pumping problems, dependable delivery and performance that lives up to promise.



WHEELER-ECONOMY HORIZONTAL, MIXED FLOW RAW SEWAGE PUMPS AT INSTALLATION

Wheeler-Economy Pumps in Operation at Dallas' White Rock Plant

- 24" suction x 24" discharge variable speed pump driven through magnetic coupling by a 250 HP, 2300 volt horizontal electric motor. Capacity 20,000 gallons per minute at 40' total dynamic head.
- 24" x 20" variable speed pump, driven through magnetic coupling by 200 HP, 2300 volt motor. Capacity 13,000 GPM at 40' TDH.
- 42" x 36" constant speed pump, driven by 400 HP, 2300 volt motor. Capacity 40,000 GPM at 57' TDH.
- 24" x 20" constant speed pump, driven by 200 HP, 2300 volt motor. Capacity 20,000 GPM at 57' TDH.

WEBB

WHEELER-ECONOMY PUMPS

ECONOMY PUMPS, INC. • DIVISION OF C. H. WHEELER MANUFACTURING CO.
19TH AND LEHIGH, PHILADELPHIA 32, PA.

Dorr-Oliver Reorganizes Sales Department

Dorr-Oliver Inc., Stamford, Conn., has announced that in order to provide better and more direct service to its customers and to centralize service responsibilities, the company recently reorganized its sales department under T. Bartow Ford, vice president in charge of sales. With the reorganization, line sales and sales services have become broad equal responsibilities.

Sanitary sales has been divided into five geographical divisions instead of the previous three. The two additions are the Southeastern and South Central divisions, with headquarters in Atlanta, Georgia, and Dallas, Texas, respectively.

W. Allen Darby continues as manager of Sanitary sales, with O. V. Lindell named assistant to the manager.

William N. Lauer becomes manager of the new Southeastern Division and William E. Bach, was named manager of the South Central division.

Keasbey & Mattison Reorganizes Sales Staff

Keasbey & Mattison Company, Ambler. Pa., has announced the reorganization of its sales supervisory staff through the creation of three separate divisions within its sales department.

Each of the new sales divisions is headed by a general sales manager entirely responsible for all phases of sales management within his division.

Heading the building materials division as general sales manager is J. F. Gorman, formerly manager of

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Equipment — Products
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the shingle and wall finish line department.

N. L. Barr, formerly district manager at Atlanta, Ga., is general sales manager of the asbestos-cement pipe division with jurisdiction over all products manufactured on asbestos-cement pipe machines.

The industrial products division is headed by Daniel Shoemaker.

B-I-F Appoints Mautner N. Y. District Sales Manager

B-I-F Industries, Inc., Provilence, R. I., has announced the promotion of Henry M. Mautner to District Sales Manager in the New York territory. Mr. Mautner will head sales operations conducted from the New York Office and sub-office in Albany.

Mr. Mautner joined B-I-F Industries in 1942 and has been managing the New England Sales Office since 1950. He holds a Masters Degree in Mechanical Engineering from the Vienna Institute of Technology, and his broad engineering and sales background includes service in Europe as well as this country. His professional affiliations include: National District Heating Association, Boston Society of S.E.'s., American and New England Water Works Associations, Instrument Society of America, Federation of Sewage and Industrial Wastes Associations, and the Providence Engineering Society.

Fischer & Porter Promotes Three

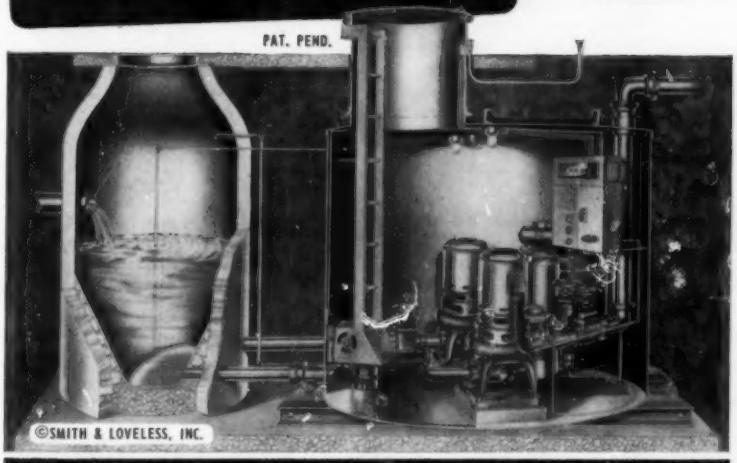
Fisher & Porter, Hatboro, Pa., has announced three promotions in its Sales Department.

Philip E. Sellers, formerly Sales Manager, becomes Sales Vice-President; Herman Kockritz, formerly Southeastern Divisional Manager becomes Field Sales Manager; and William Trethaway, formerly Sales Engineer, becomes District Manager of the Atlanta office.

HUNDREDS OF INSTALLATIONS—IN 27 STATES!

Specify—
The Smith & Loveless
FACTORY-BUILT PUMPING STATION

PROVEN QUALITY—
WITH FACTORY-BUILT SAVINGS



THE MOST ADVANCED DESIGN IN SEWAGE PUMPING STATIONS

We specialize in building America's finest sewage lift stations. Acceptance proves their quality. Smith & Loveless offer you a complete line of six standard size lift stations with capacities from 20 GPM to 1600 GPM per pump or ejector. Larger capacity stations are built to your order.

- An integrated design, each piece proven by the test of time.
- Precision assembled by factory experts.
- Automatic dehumidifier to eliminate condensation.
- A central electrical control cabinet prewired and color coded.
- Shot blasted steel structure epoxy coated plus cathodic protection.
- Factory tested and adjusted by actual operation before shipment.
- Easily and quickly installed.
- Especially designed for minimum maintenance.

For Job Recommendations, complete specifications, and drawings — all part of the latest edition of the 100 page Smith & Loveless lift station Data Manual . . .

WRITE DEPARTMENT 20

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Smith & Loveless, Inc.
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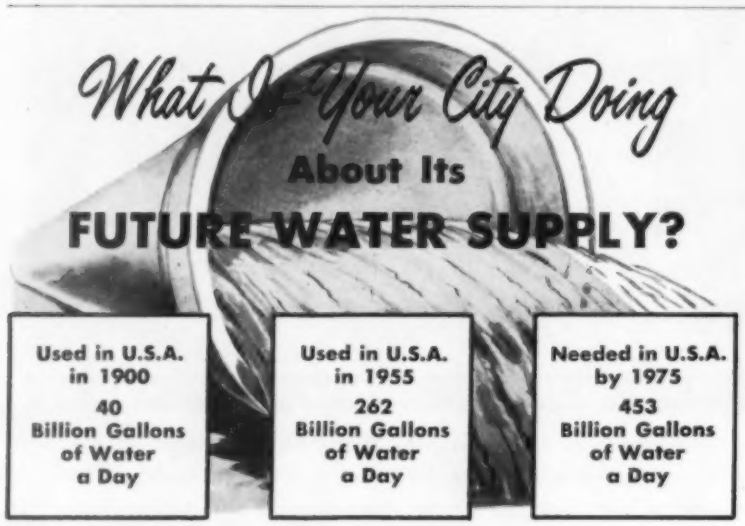
REPRESENTATIVES IN PRINCIPAL CITIES

Personnel Changes At Jeffrey

The Jeffrey Manufacturing Company, Columbus, Ohio has announced the following personnel changes: William K. Myers replaces R. W. Sweitzer as District Manager of the New York Office: Tom Fear, Jr. replaces Harley Lee as District Manager of the St. Louis Office. Lee will continue in an advisory capacity. William T. Davis, formerly of the Houston District Office, goes to Western Territory Sales Office in San Francisco as Application Engineer. William A. Lewis was appointed Sales Engineer for the Houston District Office and Ralph Bolton was named Sales Engineer for the Birmingham District Office. James A. Frazier was assigned to the Industrial Sales Division at the Beckley, West Virginia, District Office.

John Chrystal, Manager of Original Equipment Sales in the Home Office, replaces C. O. McFadden as Manager of the Columbus District Office. McFadden will continue in an advisory capacity. A. T. Loew succeeds Chrystal as Manager of Original Equipment Sales. Succeeding Loew is Dick Ross who will be Office Manager of the Merchandise Sales Division.



These figures from the Department of Commerce reveal the urgent need that exists today for many communities to plan ahead for future needs of their water systems.

When your community enlarges its water system, remember that dependable water *delivery* now and in future years is of paramount importance. Time has proved that

PERMANENT CAST IRON PIPE
Is the Best Buy

No other pipe has ever matched the record of longevity, durability, dependability, low maintenance cost and long run economy of strong and rugged Cast Iron Pipe. That is why it is rightly known as "America's No. 1 Tax Saver."

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Our Company does not manufacture pipe but supplies many of the nation's leading foundries with quality iron from which Cast Iron Pipe is made.

WOODWARD IRON COMPANY
WOODWARD, ALABAMA

Siefers Joins A. M. Byers

A. M. Byers Company, Pittsburgh, Pa., has announced that H. Kenneth Siefers, Jr., has joined the engineering service department staff.

Mr. Siefers was most recently associated with the research and development laboratory of Koppers Company at Verona and prior to that was with Hall Laboratories, Inc., a subsidiary of Hagan Corporation

He received his bachelor of science degree in chemical engineering from Carnegie Institute of Technology and served with the U. S. Army two years.

Construction Starts On Fischer & Porter's New Office Building

Fischer & Porter Co., Hatboro, Pa., has announced that work has begun on the company's new million-dollar office building in Hatboro, Pa.,

The new two-story building will have over 1,000 sq. ft. of space and will be completely air conditioned. In addition to regular office space, a new cafeteria will be constructed on a split level between the new building and the present manufacturing plant. The cafeteria will lead to a terrace on the roof of the present plant which will be used for outdoor dining during the summer months.

The new building will release a corresponding amount of floor space in the plant, permitting expansion and more efficient layout of all manufacturing facilities.

Hagan Promotes Nourse

Hagan Corporation, Pittsburgh Pa., has announced that Thomas M. Nourse has been appointed Pittsburgh district sales manager. He will be in charge of industrial sales for both the controls and the chemical divisions of Hagan.

He replaces Mr. John E. Duesing

who is now national sales manager of the controls division of Hagan Corporation. Formerly Mr. Nourse was a sales engineer at the Chicago district office for Hagan and started with the company in June 1949.

Rutherford Named President Clay Sewer Pipe Assn.

The Clay Sewer Pipe Association, Inc., has announced that Paul R. Rutherford of Cuyahoga Falls, Ohio, has been named president. He succeeds Maurice Maskrey, president since 1947, who resigned.

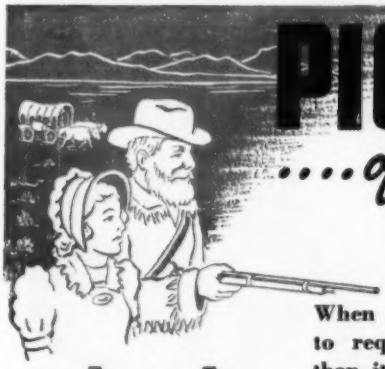
Following graduation, Rutherford was associated with the H. J. Heinz Co., of Pittsburgh, Pa., in sales for 10 years; before joining the purchasing department of Goodyear Aircraft Corp. of Akron, as a buyer in 1943. After seven years with Goodyear Aircraft, he joined the sales department of the Bessemer Limestone and Cement Co. of Youngstown, Ohio. Rutherford was named executive secretary of the Building Material Institute in 1955.

The Clay Sewer Pipe Association, which operates in the 17 states north of the Ohio River and east of Indiana, is non-profit organization, designed to develop and promote the proper use of vitrified clay pipe and related clay products. The regional organization, with headquarters in Columbus, Ohio, is a member of the National Clay Pipe Manufacturers, Inc., Washington, D. C.

Member manufacturers of the Clay Sewer Pipe Association are: Clay City Pipe Co.; Dennison Sewer Pipe Corp.; Evans Pipe Co.; Graff-Kittanning Clay Products Co.; Grand Ledge Clay Products Co.; Junction City Clay Co.; Kaul Clay Manufacturing Co.; Kaul Clay Products Co.; Larson Clay Pipe Co.; Logan Clay Products Co.; Peerless Clay Corp.; Robinson Clay Products Co.; Ross Clay Products Co.; Stillwater Clay Products Co.; Superior Clay Corp.; and Union Clay Manufacturing Corp.

Fordin' Along...

Although water is the most common and abundant material on the face of the earth few of us realize the extent to which it is constantly being created and destroyed chemically. Every bit of carbohydrate and protein formed by living plants and creatures includes hydrogen and oxygen which have come from the chemical destruction of water. Every fire of organic matter, every explosion in an automobile cylinder, even every cigarette puff, combines hydrogen with oxygen to make new water. Both chemically and physically, water is the busiest compound known to man, and the most important.

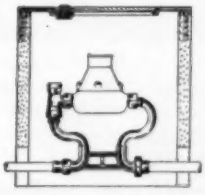


PIONEERS ....of these TIME-SAVING ECONOMIES

When a meter-servicing chore seems to require more time and bother than it is worth, Ford engineers usually come up with a new idea to save time and cut costs. Each of the products in this space was pioneered by Ford to solve an expensive service problem. It pays to refer your problems to Ford FIRST.

RESETTERS

Until the Ford Resetter was developed the only way to raise a too-low meter was to dig up and remake the setting. The modern way to do the job is to remove the meter from between the old couplings, insert the Resetter and connect the meter between the flanged copper tubes.



COPPERSETTERS

The Coppersetter is a complete meter mounting and has been widely adopted for outside meter settings in shallow and medium depth service lines. The word is copyrighted; there is no Coppersetter except that made by Ford.

RINGSTYLE COUPLINGS

The Ringstyle idea of putting the meter nut on the coupling body from the flange end permits designing meter couplings for attaching direct to iron pipe or copper tubing. There are savings in fittings, joints, labor and space.

TESTERATE INDICATOR

It is important to know the rate of flow at which a meter is tested. The Testerate Indicator shows the rate instantly, clearly and accurately. Introduced in 1938, there are almost two thousand in service.

THE FORD METER BOX COMPANY, INC.
FOR BETTER WATER SERVICES
Wabash, Indiana
FORD

U.S. Concrete Pipe & Universal Sewer Pipe Open Florida Plant

United States Concrete Pipe Company and Universal Sewer Pipe Corporation, both of Cleveland, Ohio, has announced the completion of a new concrete pipe manufacturing plant in Ft. Lauderdale, Florida.

The Ft. Lauderdale plant is the ninth pipe-making plant of the two firms which operate under one management. It occupies 20 acres, and has over 12,000 sq. ft. of manufacturing space. It will produce all concrete pipe types and sizes, including vitrified clay-lined concrete pipe, and Tylox flexible couplings for concrete pipe jointings.

Fischer & Porter Establishes Water & Waste Division

Fischer & Porter Company, Hatboro, Pa., has changed the name of its Chlorination Division to the Water & Waste Division.

Mr. Rice, general manager, states that the new name will describe more accurately, F&P's activities in water treatment, sewage treatment, and industrial waste fields through the sale of engineering services, chlorination and other chemical feed equipment, and instrumentation.

Two promotions within the division have also been announced. James F. Haskett has been named Assistant General Manager and John J. Fetch has been named Production Manager.

Chicago Bridge Adds Two To Sales Offices

Chicago Bridge & Iron Company, Chicago, Ill., has announced that N. Carey Iler, Jr. has been transferred to the Cleveland Sales Office, and Oliver E. Norris has been assigned to the company's New York Sales office.

Mr. Iler joined the Pacific Coast Erection Division of the company in 1953 and is a graduate of Cornell University. Mr Norris joined the Chicago Engineering department of Chicago Bridge & Iron Company in 1952 and is a graduate of the Colorado A & M College.

W-K-M Appoints Two Sales Managers

W-K-M Manufacturing Co., Inc., Houston, Texas, has announced the appointment of William A. Gormley as sales manager of the ACF lubricated plug valve

P. D. Nerren

W. A. Gormley

department, and Mr. Paul D. Nerren as sales manager of the pipeline department.

Mr. Gormley was with the former ACF valve division, Detroit for 20 years, serving as sales manager for 19 years of that period.

Mr. Nerren came up through the valve production side of the company—he started with W-K-M on the valve assembly line in 1934, was promoted to sales and service in 1947, and now becomes sales manager.

Hardinge CLARIFIERS for rectangular tanks

Three Hardinge primary clarifier units in 22′ x 68′ x 17′ tanks at the municipal sewage disposal plant in York, Pennsylvania. Other Hardinge equipment in this plant—final clarifiers, sludge thickener and digesters. (Albright & Friel, Consultants)

Hardinge has installed more than 70 rectangular clarifier units for municipal sewage treatment, oil refinery wastes and miscellaneous industrial liquid wastes—processing in excess of 300 million gallons of liquid daily.

Complete specifications for all types and sizes upon request. Bulletin 35-D- 15.

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COMPANY, INCORPORATED

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U.S. Pipe Promotes Finn

United States Pipe and Foundry Company, Birmingham, Ala., has announced the appointment of John C. Finn as Assistant to Sales Manager—Pipe. Mr. Finn will be located at the General Office in Birmingham, Alabama. He is a graduate civil engineer from Northeastern University and has been associated with the Boston Office since 1937, first as a sales representative and since 1954 in charge of the office as Sales Agent.

Announcement has also been made of the appointment of Whitney K. Stearns as New England Sales Agent replacing Mr. Finn. Mr. Stearns is a graduate civil engineer from Swarthmore College. He has had several years experience in the cast iron pipe business as a sales representative in U. S. Pipe's New York Office since 1948.

Graver Opens Boston Office

Graver Water Conditioning Co., New York, New York, has just announced the opening of a new sales—service office in Boston, Mass. to service the New England area. The office will be located at Room 707, 6 Beacon Street, Boston, Mass. Telephone: 7-9414.

Mr. William A. Homer will be District Manager in charge of this office and will handle Gravers' complete line of Industrial and Municipal Water Treatment and Industrial Waste Treatment Equipment.

Mr. Homer, who graduated from the University of Maryland with a Mechanical Engineer degree, has been with Graver since 1952 in their Customer Service Dept., where he obtained a practical working knowledge of their equipment, and their Sales Engineering Dept., where he designed and selected equipment and processes for all types of water and waste treatment problems.

CORRECTION

Neptune Meter Appointment

In our August issue, it was erroneously reported that Mr. John Paul McCullough had been named manager of the Neptune Meter Company's Atlanta branch office.

Mr. McCullough was appointed sales representative for the company in the States of North and South Carolina by Mr. R. C. Lewis, Atlanta Branch Manager for Neptune.

how to CUT CORROSION LOSSES

a report by Koppers Company, Inc.

C. U. Pittman
Supervisor Technical Service

Ideally, effective corrosion control should start in the design stage of a new building or unit. The design engineer—by avoiding sharp edges, grooves, thin supporting members, etc.—can eliminate many of the common starting points for corrosion.

But in any case, the first step in preventing corrosion is *adequate preparation of the surface* before applying the protective coating. A really good—and economical—protective coating should *prevent* corrosion, not just cover corrosion products.

* * *

Most authorities agree that there are two chief objectives in good surface preparation: removing contaminating materials and producing a surface that will promote a good mechanical bond with the coating. The life and effectiveness of the coating system depends upon the degree to which you attain either of these objectives.

Actually, a tightly adherent surface of mill scale would make an ideal protective coating in itself—*if* temperatures remained constant. But since the scale and the virgin metal have different co-efficients of expansion, temperature changes and mechanical flexing cause flaking of the mill scale even under coatings. (Note: In over-the-ditch coating, it is not practical to remove all mill scale—buried pipe is not so subject to temperature change.) Another problem with mill scale is that electrochemical action between the mill scale and the metal accelerates corrosion and causes pitting.

Rust provides a certain amount of protection by slowing corrosion. But since it is non-adherent and porous, corrosion continues.

To perform an effective, long-life job, any coating must have a proper surface to which it can adhere. As revealed by photomicrographs, a slight roughness produces the best mechanical bond by increasing surface area and providing a tooth for the coating. Chemical bonding depends on the inherent molecular structure of the coating material. Some coatings must depend on a mechanical bond only. But coal tar coatings, having polar groups, will bond chemically as well as mechanically.

* * *

The important point on which most corrosion engineers agree—and which our applications research has proved—is that surface preparation is an integral part of the coating specification. By paying as careful attention to surface preparation methods as to selecting the right coatings, you will assure trouble-free, economical corrosion control.

* * *

We will report to you soon on the various surface preparation methods. In the meantime, we'd like to hear about your corrosion problems. Write: Koppers Company, Inc., 1301 Koppers Building, Dept. 109J Pittsburgh 19, Pa. District Offices: Boston, Chicago, Los Angeles, New York, Pittsburgh and Woodward, Ala. In Canada: Koppers Products, Ltd., Toronto, Ontario and Edmonton, Alberta.

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M-C-G Company, 1771 W. 5th Ave., Columbus 12, Ohio

Alabama Pipe Opens Kansas City Office

Alabama Pipe Co., Anniston, Alabama, has announced the establishment of a new sales office at 950 Dierks Building, Kansas City, Mo.

Heading up the new Kansas City office is D. C. (Doc) Shaw, who will represent the company in western Iowa, Nebraska, North and South Dakota, Kansas, Missouri and Oklahoma.

Kociencki Joins Marlow Pump

The Marlow Pumps Div., of Bell & Gossett Company, Midland Park, N.J., has announced that Harry Kociencki has joined their sales staff at the home office.

Mr. Kociencki graduated from Stevens Institute of Technology in 1954 with a M. E. degree. He then joined the Worthington Corporation where he went through their intensified training program and worked in their vertical turbine pump division as an application engineer.

Infilco Moves Crowley to Atlanta Area

Infilco Inc. has announced the movement of Ed Crowley to the Atlanta area. He has been with the company for almost five years. Before that time he spent thirteen years in the Paper and Pulp industry in Houston and Minneapolis.

Mr. Crowley will take his position at once and specialize in the fields of municipal and industrial water supplies and waste treatment. His long association with the paper industry fits him for special service in this rapidly expanding industry in the Southeastern States.

Engineering Enigma

In Russia, we are told, about 25% of all graduate engineers are women. In America the figure is less than 1%. Is this good—or bad?

W&SW

New Literature

Dorrco Monorake

920

Dorr-Oliver Incorporated, Stamford, Conn., has announced the availability of a new, twelve-page, two-color bulletin, **"The Dorrco Monorake."**

This bulletin describes the design, types and sizes, operation and advantages of this mechanism for cleaning rectangular sedimentation basins and tabulates actual maintenance costs from a number of installations. Sketches, line drawings and installation photographs of the unit and its components are included as well.

According to the bulletin, the Dorrco Monorake is expressly designed for rectangular settling tanks employed in water, sewage and industrial waste treatment plants. It is basically different in design from other rectangular units and includes a number of exclusive features which reduce operating and maintenance costs.

Butterfly Valves

921

F. B. Leopold Co., Inc., Pittsburgh, Pa., has just published an illustrated, 2-color brochure describing **Leopold Rubber Seated Butterfly Valves.**

Included in the new literature are complete details on the performance and construction features of the valve, along with designated parts of the valve assembly.

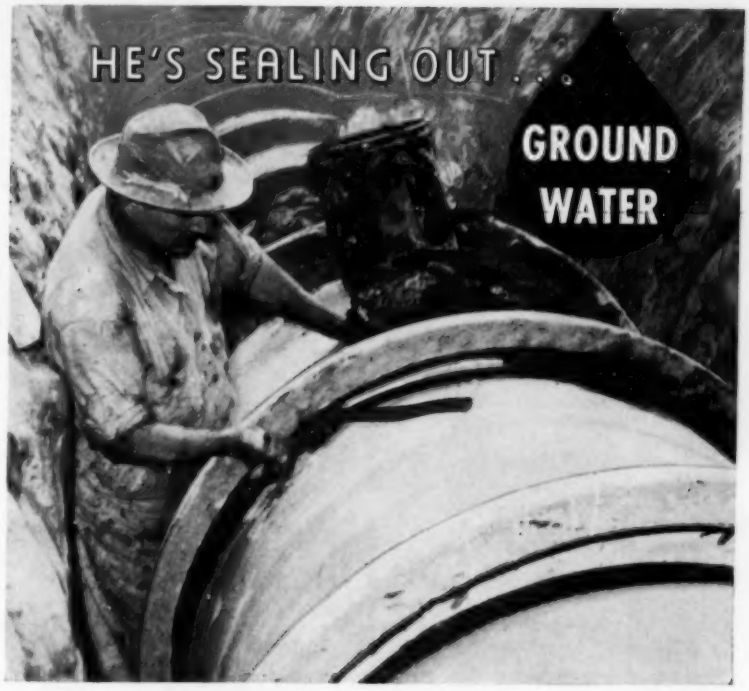
Hydromatic Valve

922

Cochrane Corp., Philadelphia, Pa., has just released a bulletin describing the **Hydromatic Valve** used in control of Demineralizers, Zeolite Softeners, Dealkalizers and Pressure Filters.

The bulletin states that the valve was developed to eliminate the complicated nest of individual valves required for the control of the various stages of service, backwash, regeneration, rinse and return to service.

The publication describes the design features, operation and advantages the valve offers operators of ion exchange equipment.



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3. KALKTITE,® a cold-mixed, cold-applied joint sealing compound, used to fill the balance of bell. Sets up **internally** under the most adverse conditions. Forms a dense, tough, flexible seal.

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Submersible Pumps

923

Bryon Jackson Div., Los Angeles, Calif., has just published a new 12-page bulletin describing the line of **BJ Submersible** pumps.

Construction and operation of pump, motor and seal (both mercury and mechanical) are shown in cutaway detail. A handy selection chart is provided, giving capacity and head performance within the BJ Submersible line. Units range from 5 to 900 horsepower and from 30 gpm capacity to 30,000 gpm and above. Four basic pump types come in a wide variety of impeller and bowl combinations to answer any pumping problem.

The advantages of submersibles for booster, service, lake and river intake, primary water supply, irrigation and special applications are outlined. Typical municipal and industrial users are listed.

Continous, Recording Turbidimeter

924

General Electric Company, Schenectady, New York, has just released a bulletin on **Recording Turbidimeter For Continuous Measurement and Recording of Suspended Matter In Liquids.**

This attractive 4-page bulletin describes features, application, caibration, instllation and operation tion of the analytical process instrument.

Guniting For Water & Sewage Plants

925

Pressure Concrete Company, Florence, Alabama, has available a series of booklets containing job histories and typical specifications on **Gunite** and its application to sewage plants, and water treatment plants.

PIPE FOR SALE—NEW—IMMEDIATE DELIVERY

1141 feet BLACK SEAMLESS STEEL CASING—5" OD X 18# T & C

38 Jts: This is new pipe purchased from Valley Steel Products in December at a cost of $2150. NO increase in price. Near Poplar Bluffs, Mo.

Call or wire Glen C. Bull, 2800 Quebec st, N.W. Washington, DC, or Ph. EM 3-5758.

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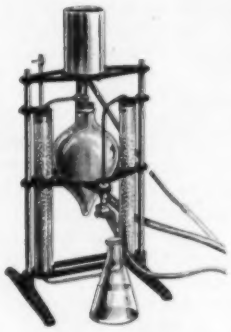

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Wilkes-Barre, Pa.

New Film Shows Pretesting Of 400 MGD Pumps

926

Byron Jackson Pumps, Inc., Los Angeles, Calif., has announced a new 18-minute, full-color sound film entitled **"Model Test Pit for 400 MGD Pumps."** This film—actually an engineering report—shows how the engineers at Byron Jackson thoroughly pretested the BJ pump installation for the giant Tidewater refinery in Delaware—the largest new refinery ever built.

This filmed report shows the tests that were made in Byron Jackson's Los Angeles Hydraulic Laboratory where a model tank—along with nine model vertical circulating pumps—was constructed to duplicate the actual field operation at Delaware. The tests—designed to answer the unique hydraulic problems of the Tidewater project—consisted of studies of water flow, swirling, effect of opening or closing entrance gates, possible concrete cavitation, permissible minimum water level, effects of high tide, and arrangements of intake gates and screens. Extensive animation is used in the film to demonstrate variations in pumping situations.

This film is available to all interested groups and organizations.

Standard Sluice Gates

927

The Filer & Stowell Co., Milwaukee, Wisconsin, has just published a catalog on the company's line of standard **Sluice Gates.**

The 40-page catalog gives complete data on circular and rectangular gates for seating and unseating pressures. There are installation suggestions, photographs and charts as well as guide form specifications. All the information is presented in an easy-to-understand form.

Sewer Cleaning Units

928

Turbine Sewer Machine Co., Milwaukee, Wisconsin, has available a catalog describing the **Turco Maxi-Power Sewer Cleaning Units.**

The catalog discusses how sewer cleaning jobs are performed faster and with greater efficiency by the use of the Turco units. Each unit consists of two identical sewer cleaning machines.

60" Pratt Rubber Seat Butterfly Valves in presedimentation basin piping of the Florence Water Treatment Plant, Omaha, Nebraska.

OMAHA... Butterfly Valves are key to compact piping

This ultra-compact arrangement of three 60 inch valves could only be made with Butterfly Valves. The illustration shows the narrow face-to-face dimensions (only 15") and the compactness of the valve-operator assemblies. What you can't see is equally important! The rugged internal construction—the rubber seat that is never under severe pressure from the valve disc, only partially displaced during closure... features that mean years of easy operation without maintenance problems or costs.

Pratt originated the Rubber Seat Butterfly Valve and has installed more of them than any other manufacturer.

For valve design with a 50 year reputation for practical imagination, see Henry Pratt.

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List of American Standards

929

American Standards Association, New York, N. Y., has just published a new **List of American Standards** that indexes 1600 American Standards.

About 275 of these are in the field of civil engineering and construction. They include codes for building and plumbing, test methods and specifications for building materials of all types, fire tests and safety precautions in construction, modular coordination and many other related items.

The 56-page booklet also describes the work of the Association, gives information on how to purchase both American Standards and those from other countries.

Sewage And Sludge Pump

930

Chicago Pump Company, Chicago, Ill., has just published a bulletin on the **SP-5 Sewage and Sludge Pump.**

This attractive 8-page, color bulletin shows actual installation photographs of the pumps along with a short description of the operating functions of the pumps. The center fold contains a cut-away drawing keyed by number to the parts list. Complete specifications are also given. Three curve charts show approximately the characteristics of the pumps when pumping clear cold water.

Pumping and Sewage Treatment

931

Yeomans Brothers Company, Melrose Park, Illinois, has just published an architects' and engineers' reference manual dealing with **Pumping and Sewage Treatment Equipment.**

The manual gives detailed information for determining capacities of, and selecting vertical wet pit pumps and pneumatic ejectors.

Included in the section dealing with vertical wet pit pumps is (1) a table for rating fixture units, (2) a curve for estimating pump capacity and (3) a table for determining friction of water in pipes.

The section covering pneumatic ejectors discusses the various types available, how they operate, and how to select the correct pneumatic ejector for a given job.

A four-page section devoted to pictures and detailed descriptions

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Surer Gland Lubrication for Centrifugal Pumps

THE Z-F GREASE SEAL eliminates that trouble spot where shaft enters casing. Applies constant positive lubrication to packing and shaft—automatically. Excessive heat, rapid wear, leakage and scoring will disappear as the Grease Seal applies a constant flow of lubrication when pump starts until it stops—automatically. Many other advantages, too. Write for complete description and price. **ZIMMER and FRANCESCON**, Moline, Illinois.

ZF

of wet pit submerged centrifugal pumps covers (1) screenless ejector pumps for solids-bearing wastes and heavy viscous materials, (2) bilge pumps for handling solids-free liquids, (3) top suction type bilge pumps and (4) pedestal mounted "Drain-Dri" sump pumps.

A special "selector guide" lists various Yeomans products, model numbers, typical applications, and the specific technical bulletin (available on request) which describes the product in question.

A two-page section is also devoted to sewage and industrial waste treatment systems.

Portable Mixer

932

Cleveland Mixer Co., Cleveland, Ohio, has released a data sheet on the **Cleveland Portable Clamp-On Mixer.**

The data sheet discusses the exclusive features such as: interchangeable motors; interchangeable gears; and interchangeable shafts to fit any application. The back page illustrates and explains the construction details of the mixers.

Pneumatic Ejectors

933

R. B. Carter Sales, Inc., Hackensack, New Jersey, has announced the publication of a comprehensive new catalog describing their line of **Pneumatic Ejectors.** Clearly written and graphically illustrated, this highly informative 28 page book points out the advantages of using pneumatic ejectors for sewage boosting, controlled pumping of sludges, efficient handling of all solid-laden liquids.

Descriptive data on Principle of Operation, Construction Features, Operating Arrangements, Selection Data, Air Tank Data and Dimensions, Air Compressors, Layout Dimensions and Specifications are included.

Deaeration

934

Cochrane Corporation, Philadelphia, Pa., has just published a bulletin on **Deaeration—Why? How?**

The bulletin explains in capsule form the fundamentals of deaeration and why it is so necessary in water conditioning. The principles of operation as well as the advantages and application of the various methods of deaeration are discussed.

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❶ Answers High-Bill Complaints
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❸ Detects Presence of Leaks

The NEW RE-DESIGNED MODEL 542P of the world-renowned

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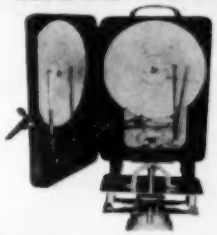

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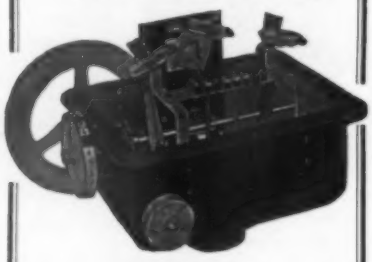

RF-2

WITH ALTO-TROL

This 2-pump RF-2 Roto-Trol assures equal use and wear of both pumps. Each pump is operated on alternate starting cycles.

The RF-2 operates both pumps together, when required. RF-2 installations give dependable service year after year, with the minimum of attention.

Write for full data

WATER LEVEL CONTROLS DIVISION

HEALY-RUFF COMPANY

783 Hampden Ave., St. Paul 4, Minn.

Chlorine Handling Equipment

935

Wallace & Tiernan Incorporated, Belleville, N. J., has just published new literature describing equipment used by industry for **Handling Liquid and Gaseous Chlorine.**

The new literature illustrates and describes such chlorine handling equipment as: Liquid chlorine evaporators, valves and fittings for chlorine liquid and gas supply lines, manual and pilot operated chlorine pressure reducing valves, and chlorine gas metering equipment.

Swimming Pool Sanitation

936

Columbia-Southern Chemical Corporation, Pittsburgh, Pa. has just published a new eight-page, two-color brochure on swimming pool sanitation with **Pittabs,** a new slow-dissolving tablet form of calcium hypochlorite.

The booklet contains directions for using the tablets in various types of pools, a table of amounts to be used according to pool gallonage, information on handling and storing the product and a list of other than swimming pool applications for the tablets.

Pressure Filters

937

Infilco Incorporated, Tucson, Arizona, has released a bulletin on the **Surflex Filter.**

According to the bulletin, the "Surflex" filter is a diatomite pressure filter which retains the desirable features of sand filter design. The horizontal filtering surfaces make it suitable for handling either intermittent or continuous water flows, and the complete absence of any metals at the filtering areas precludes the possibility of corrosion difficulties.

By means of engineering drawings and text the bulletin shows filtering operation; cleaning procedures; filter aid requirements; and assembly positions. A dimension chart is also included.

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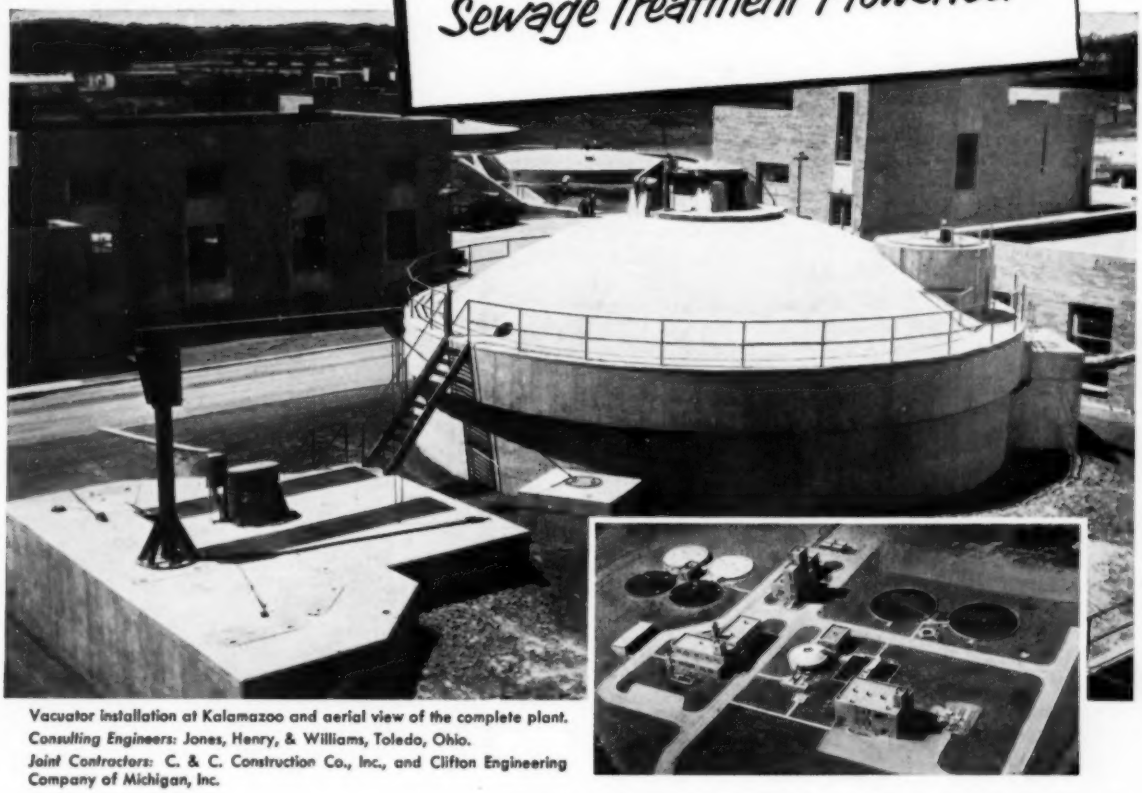

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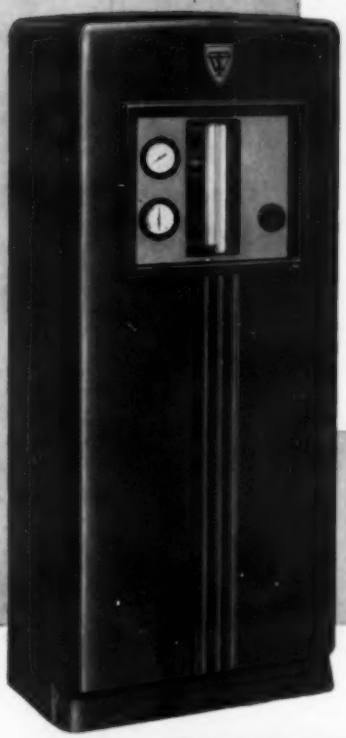

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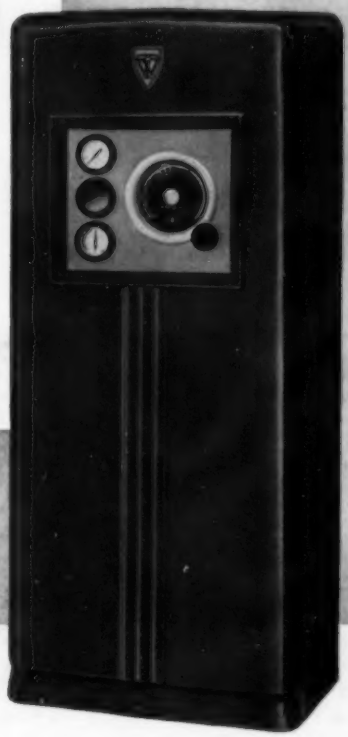

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With the new Wallace & Tiernan V-notch Variable-Orifice Chlorinators:

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SETTING FEED RATE IS SIMPLIFIED as one control sets feed rate precisely at both high or low feeds.

INSTALLATION IS SIMPLIFIED as units are shipped ready for operation. No water supply is needed at the chlorinator. A remote injector uses only standard water supply fittings.

MAINTENANCE IS SIMPLIFIED and virtually eliminated. All parts are corrosion resistant, mounted in an attractive modern cabinet.

For full details on manual or automatic proportional V-notch Chlorinators, contact your W&T representative, or write to the address below.

A New Development from Wallace & Tiernan Research

WALLACE & TIERNAN INCORPORATED

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